RLC-3 8 Port Communications Controller
Software Version 1.46

Link Communications, Inc.
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Introduction:

Congratulations, you have purchased a very powerful tool for your group's repeater. The RLC-3 may seem complicated and intimidating at first, but don't worry. Setting it up and programming it are easy and straightforward, once you have read the manual. Please take the time to read it before you try to start programming. This will save you a lot of confusion and frustration, as it should answer most of your questions.

The RLC-3 communications controller supports up to 8 radio ports and two I/O boards (8 analog voltage inputs, 8 logical (dry contact) inputs, and eight MOSFET output drivers each). The radio ports can be configured to require one of several combinations of COR and PL inputs for access. The RLC-3 has a DTMF decoder per radio port card, thereby supporting DTMF control from all ports of the controller. Synthesized voice prompts the users in the programming of the controller's variables, provides voice ID's and alarms based on the inputs, etc.

This manual consists of three main sections: setup and interfacing, programming and commands, and the appendices with commonly referenced tables and charts. A glossary has also been included at the end to explain some of the terms and abbreviations that are used throughout the manual.

We have attempted to explain everything in a way that is easy to understand, but some questions are inevitable. If you have carefully read the manual and still have questions, call us at (406) 482-7515, fax us at (406) 482-7547, or write to us at

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Link Communications Inc. warrants that its products will be free from defects in materials and workmanship for a period of one year from the date of shipment. During this time, Link Communications Inc. will cover parts, labor and return shipping. If failure is caused by instances other than manufacturing defects, Link Communications Inc. will repair the product and bill the customer for parts and labor. Contact Link Communications Inc. for more information.

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3. Incorrect unit installation.

4. Damage caused by shipment (damage claims are handled by the carrier).

6. Repairs by other than Link Communications Inc.

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Please contact Link Communications Inc. for servicing information and authorization.

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Link Communications holds the copyright on the RLC-3's software and hardware. Changes to the software, copying of the software, and use of the voice code is prohibited without the written consent of Link Communications.

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Link Communications Inc. will provide FREE Software updates for 6 months from the date of purchase. The owner must return replaced software chips to Link Communications in order to obtain further software updates. Software updates costs will be determined at the release of the update. Manual inserts and shipping are additional.

User Survey (Optional)

A knowledge of the user base will allow us to better serve you in the future by helping us develop more specialized software and hardware. Please take a few minutes and fill out this questionnaire.

RLC-3 Serial Number .... _____
RLC-3 Purchase Date .... _____

Application: (Circle All That Apply)
 Ownership:
   - 1 - Privately Owned Repeater
   - 2 - Club Owned Repeater
   - 3 - Group Owned Repeater
   - 4 - Commercial Business Repeater
   - 5 - Other _____

 Installation:
   - 1 - Wide Coverage Repeater with Chain Links
      - Port to Port Linking
   - 2 - Full Duplex Links
   - 3 - Half Duplex Links
   - 4 - VHF Repeater: Power _____ Make _____
   - 5 - UHF Repeater: Power _____ Make _____
   - 6 - Link Ports Used as Repeater Ports: Yes No
   - 7 - Serial Data Used to Control Repeater: Yes No
   - 8 - Other Amateur Repeaters At the Site: Yes No
   - 9 - Other Link Communication Inc. Products Used: Yes No

 Misc:
   - 1 - User Base: Technical Rag Chew Personal
   - 2 - Autopatch used on the System: Yes No
   - 3 - Frequency Adjustable Remotes: Yes No
   - 4 - Linking to Other Repeaters: Yes No
   - 5 - Linking Closed Access: Yes No
   - 6 - PL Required on Main Repeater: Yes No Varies
   - 7 - PL Required on Linking System: Yes No Varies

Please Return to: Link Communications Inc.
          P.O. Box 1071
           Sidney, MT. 59270

Comments:

Setup and Interfacing

This section of the manual contains everything you should need to know to get your repeater controller up and running. The numbered steps cover the basics, through connecting your radios and adjusting the RLC-3. After that there is information concerning the other input and output features of the RLC-3: the serial interface, the logical output and input lines, and the analog input lines.

Step #1: Check the Packing List
Your package should contain the following items:
 (1)   RLC-3 Repeater Controller and cabinet
 (4)   Linking Cards (unless more have been purchased)
 (1)   2.50mm Power Connector
 (1)   DB-9 Male Solder Connector for each radio port
 (1)   DB-9 Male Solder Connector for the serial port
 (1)   RLC-3 Manual
If any of these parts are missing, contact Link Communications Inc.

Step #2: Connect Power
- The RLC-3 was designed to run off of 12V DC. 11V to 14V should work fine.

- Locate the 2.50mm power connector included in your parts bag.

- Unscrew the plastic outer shield and thread your power and ground wires through it (20 gauge suggested).

- Solder the +12V wire to the center pin of the 2.50mm connector.

- Solder the ground wire to the shield of the 2.50mm power connector.

- Screw on the plastic outer shield.

- When power is applied to the RLC-3 controller, the 5 LED's on the RLC-3 power board should light, indicating proper board operation. **If all of the LED's do not light, turn off the power immediately**.

Step #3: Connecting Your Receivers to the RLC-3
The radios connect to the RLC-3 using a male DB-9 connector (included). The pin-outs are listed below.

Radio Ports

1 - Ground
2 - PL Input (Active High/Low)
3 - PTT Out (Active Low)
4 - Audio Out (to the transmitter) 600 Ω
5 - Audio In (from the receiver) 10K Ω
6 - Ground
7 - COR Input (Active High/Low)
8 - Ground
9 - Ground

Connecting the Receiver COR
The first step in connecting your receiver is to locate an active receiver signal. If the voltage goes from a voltage above 5 volts to ground when a signal is present, the signal is active low. If the voltage goes from a ground to a voltage above 5 volts the signal is active high. Either polarity of COR signal will work if the switch #2 (labeled "CR") is switched correctly. The signal must be able to sink 4mA to ground. The input impedance of the RLC-3 COR input is 10KΩ and it is diode clamped with internal pull-up resistors. This allows it to handle input voltages of up to 40 volts without damage to the controller. **The COR input must not go below 0V (ground); this would damage radio card's COR/PL input.** Using one of the supplied DB-9 Male connectors, connect your COR signal to pin #7. If the signal is active low, turn switch #2 on; if the signal is active high, turn the switch off. The LED labeled RX will light when a correct activity signal is received. If the LED lights at the wrong times, you probably have switch #2 set wrong. If the LED does not light at all, the RLC-3 is not detecting your COR/PL input correctly. Use a volt meter to make sure that the signal from your receiver changes from ground to above 5 volts (or vice versa) when the receiver goes active.

Connecting a PL Input (optional)
If you wish to use a PL (CTCSS) decoder on any of the receivers, its detect line can be connected to pin #2 of the appropriate connector in the same fashion as the COR input. You can select the PL polarity with switch #3 (labeled "PL"). You will probably also want to use the audio filter on the PL decoder board to filter the PL signal out of the receiver's audio before it goes to the RLC-3.

Connecting the Receiver Audio
- 2 types of audio can be used on the RLC-3 controller:

    Type 1: De-emphasized audio (Speaker Audio)
    Type 2: Discriminator audio (Raw Unsquelched Audio)

- If type 1 audio is used, set configuration switch #1 (labeled "DM") to the "OFF" position
This removes the de-emphasis filter from the circuit. If you are using discriminator audio,
turn switch #1 on. The filter will not allow PL to pass through the controller. Contact Link
Communications Inc. if you need to pass PL through the controller.

- The audio input is connected to pin #5 of the male DB-9 connector
- The audio adjustments will be described in Step #4.

Summary of Switch Settings

- Switch #1 (labeled "DM"): If this switch is on, the de-emphasis filter will be connected to
  the input audio circuit. You would use this setting for discriminator audio. If this switch
  is off, the audio is "flat" through the controller. You would use this setting for speaker
  audio.

- Switch #2 (labeled "CR"): If this switch is on, the COR signal will be treated as an active
  low signal (ground when a signal is present, above 5 volts when absent). If it is off, the
  COR signal will be treated as active high.

- Switch #3 (labeled "PL"): If this switch is on, the PL signal will be treated as an active
  low signal (ground when a signal is present, above 5 volts when absent). If it is off, the
  PL signal will be treated as active high.

- Switches #4 and #5 (labeled "A1" and "A2"): These switches are not currently used.

```
                        DM      PL      A2
                        | CR    | A1    |

                       ┌─────────────────────┐
                        1   2   3   4   5
                                                    ON
     Configuration     ▯   ▯   ▯   ▯   ▯        ^
         Switch                                     |
                                                    |
                        OFF                     OFF
                       └─────────────────────┘
```

Copyright 1995 Link Communications Inc.
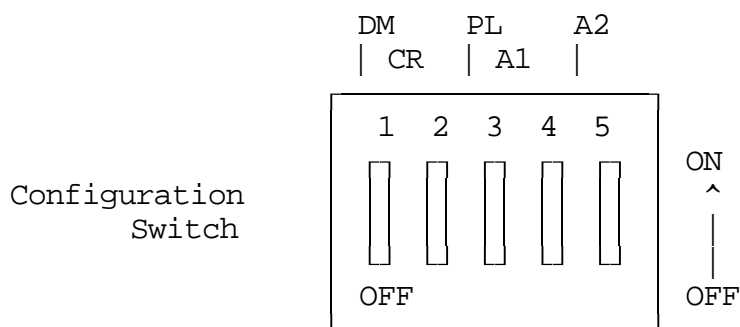
Step #4: Connecting Your Transmitters to the RLC-3

Transmitter PTT
- The RLC-3 produces an active low PTT signal (ground when PTT is active). This output is buffered with an open collector type driver capable of sinking 150mA. There is a built in 30V zener clamping diode to protect the PTT MOSFET from the high voltage spikes that can be caused by interfacing to a PTT relay coil. Your transmitter PTT input should be connected to pin #3 of the DB-9 connector.

Transmitter Audio
- The RLC-3 provides a 10KΩ output impedance to your transmitter audio input.
- The transmitter audio is connected to pin #4 of the DB-9 connector.
- If it is not already, the DB-9 plug can now be plugged into the appropriate jack on the link card. The radio port is the lower DB-9 on the link card (with the DB-9s toward you).

Step #5: Adjusting the RLC-3 Controller

- Locate connector P4 on the RLC-3's main board. (It is the 10 pin female connector located near the power connector and above the serial port connector). This test bus will provide the signals that we need to adjust the audio inputs on the RLC-3. In order to maintain audio deviation during channel switching, all of the receiver inputs must be set to the same level. These signals can be measured with an oscilloscope or an AC voltmeter. If you are using an AC voltmeter, remember that it reads AC signals as RMS values. In order to obtain an audio signal on P4, a valid COR or PL must be received. Once a valid access signal is received, the RLC-3 will un-squelch the audio and be present on P4.

Receiver Port Adjustment:
- Connect the receiver port that is receiving a signal to all connected transmitter ports.

Transmitter Port Adjustment:
- Present a stable Tone or DTMF tone to the receiver that you are adjusting.
- Adjust the 'RX' pot so that the signal on P4 is 1 volt peak-to-peak for the active receiver
- Adjust the 'TX' pots on all other connected transmitters to obtain the desired deviation.
- Your transmitters should not need any additional adjustments once 1 receiver is set up.

Follow the above adjustment steps for all other connected receivers

Voice Level Adjustment:
- Generate a voice test message using RLC-3 command C036
    Example: C036*001002003004005006007*
- Adjust 'Voice Level Adjust' pot to 2 Khz deviation, this adjustment is for all transmitters.

Tone Generators Adjustment:
- Generate a tone test sequence using RLC-3 command C040
    Example: C040*5000001000
- Adjust "TN" pot on the RLC-3 port card to your requested deviation
- 1.5Khz deviation is typical

Serial Port Interfacing

The RLC-3 has a full duplex serial terminal port for interfacing to any serial device, i.e. packet, modems and serial terminals. This allows you to monitor, control, and program all facets of the controller.

RS-232 Signals and Interfacing

The RLC-3 input and output is the RS-232 standard, ±12V. The pinout is standard for a 9-pin serial connector. To connect to a terminal or computer's 9-pin serial connector, use a straight-through cable (not a null modem) with at least pins 2, 3, and 5 connected. To connect to a computer with a 25-pin serial connector, you can use a standard 9 to 25-pin converter or wire your own cable. To wire your own, connect the RLC-3's pins 2, 3, and 5 to the computer's 3, 2, and 7 respectively.

Communications Parameters

After connecting your terminal, computer, or modem (either packet or telephone) to the RLC-3, you need to make sure that the communications parameters match on both ends. The default settings for the RLC-3 are 9600 N81:

Baud (Default)	9600
Start Bits	1
Stop Bits	1
Parity	None
Word Length	8

You can change the baud rate the RLC-3 uses with command C024. Information about programming using the serial port can be found in appendix G.

Getting Started

This section contains general information that you will need to know to use the RLC-3. It does not contain very much information that you can't find elsewhere, but it is provided to help you get on the air without having to read the whole manual. It explains some basic things about how the controller works, how to enter commands, and provides some examples to get you started. If at any point you are confused, read the more lengthy descriptions of what each command does in the Command Reference section.

Reset and Power Up

When the RLC-3 resets (this occurs when the reset button is pressed and released, you power up the controller, or command C035 is executed), the reset macro is executed. This macro is user programmable and defaults to sending 'Reset ?' in CW. This message is the first message that you will hear. The message sent will only go out port 1 of the RLC-3. When this message is sent you know that one of the following events have occurred.

1) Power has just come back on

2) The user has pressed the "RESET" button

3) The Reset command has been executed by the controller or the user

4) The controller's watchdog timer has expired. This is an internal protection timer.

If you want a different message to be sent on reset, or you want to change the configuration of something, you can simply put the appropriate commands into the reset macro.

The EOF key

The EOF key is a name used to describe the digit that forces a command to be executed. This key defaults to the '*' key but can be changed to any digit. It is recommended that the assigned key be a digit not used by any other command names (*, A, B, and D work fine, # is usable, but not ideal). This is important so that commands are not executed when they are not intended to be executed. Other controllers may assign this digit as the 'D' key.

When and Why do I use the EOF key?

After you enter a command name, there are two ways you can cause it to execute. The first is to press the EOF key ('*'). The second is to unkey your transmitter. There are advantages and disadvantages to each method. For example C009 can be executed two ways:

    Method #1: C009*
    Method #2: C009 <Receiver Access Drop>

Method #1 executes by forcing command execution with the '*'. When this is done the response begins immediately, and does not wait for the receiver access to drop. The advantage of this type of execution is the command executes immediately, allowing you to enter multiple commands without unkeying between them. The disadvantage is that you will probably miss part of the cw response.

Method #2 executes when the receiver goes inactive. The advantage of this type of execution is the response is not sent until after the receiver goes inactive, therefore allowing you to hear the complete message. The disadvantage is that the command will wait on receiver activity before executing a command. This is a problem if your receiver's squelch is locked open and you need to shut down or enable PL on your system. With Method #2 the command would never execute because the receiver's access never went inactive.

Both methods are always available, so you can use whichever one you choose at the time. If you want to enter a bunch of commands without unkeying and you don't care about the responses, use Method #1. If you want to hear the responses, use Method #2. Method #1 is always used in the manual.

Another time that you may need to use the EOF key is if the command you are using requires data following the command name. An example of this type of command is C000, which connects two ports together. After you enter the command name, you must press the EOF key, then the two port numbers you wish to be connected together, then use either of the methods described above to make the command execute:

    C000*12 <unkey or press *>.

In other words, the EOF key indicates the end of the command name and the beginning of the data for commands that require data after the command name.

There is a way to make the controller enter the EOF key for you as soon as it recognizes that you have entered a valid command name. This is called "autoexecution". With autoexecution is turned on, the above example would become C000 <controller recognizes command name and enters the EOF for you> 12 <unkey or press *>, so all you have to enter is C00012*. If the command does not require data after the command name, it will be executed immediately when the controller automatically enters the EOF, just like Method #1 above. If you key and enter C009C009, command C009 will be executed twice, even if you don't unkey.

Autoexecution can be used to make using the autopatch easier. To dial a number without autoexecution, you would enter something like C112*4064827515 <unkey>. With autoexecution turned on, you would just enter C1124064827515 <unkey>. Of course you can change the name of the forward dial command from C112 to almost anything else.

Example: I will make an autopatch call using normal and auto execution modes.
    - My autopatch access command is named 321 and my number is 482-7515
Normal :
    321*482 7515 <Receiver Access Drop>   Autopatch dials the number
With Autoexecution:
    321 482 7515 <Receiver Access Drop>   Autopatch dials the number

How do I change the EOF key?

You can change the EOF key using Command C080. All ports including the serial port default to '*' as the EOF digit. Refer to the command description for the correct format in changing and recalling the digit.

How Command Names and Command Numbers are Used :

The RLC-3 controller has 1000 commands. The first 200 are commands that do a specific task. The reset of them are macros, that can perform a sequece of other commands. Any of the 1000 commands can be executed by either DTMF over the air, or RS-232 serial from the serial port. Each command can be refered to in two different ways, by name or by number.

Command Names:

When you wish to execute a command, you enter its name, possibly along with the EOF digit and some data. The names of the commands in the RLC-3 default to C000, C001, C002...C999. Of course you can change these names to anything 1 to 6 digits long. The name can be composed of both DTMF data and ASCII data from the serial port. This flexibility allows the user determine access to commands solely by their command name. If you only want some commands to be executed from the RS-232 serial port then assign a Command Name that contains digits that are not found on a DTMF pad. That command can not be executed from the DTMF keypad anymore.

Remember: Command names are what you enter to execute a command.

Command Numbers:

The command numbers are closely related to the command names. All of the commands are kept track of internally as command numbers 000 through 999. These command numbers never change - number 009 will always refer to the same command. The command names default to being a 'C' plus the command number, so command number 009 would be named C009. Because of this, you can always find out what a command's number is by looking up its name in the manual and removing the 'C'. The importance of the command number is that you use it when you tell the controller to change a command name or program a macro. This is done so that you can program macros the same way even if the name of the commands you are using have changed.

Converting Command Name <--> Command Number

Command Number ---> Command name is accomplished with Command C011

If you have forgotton the name of command number 009, you can find out what it is with C011 (enter "C011*009*"), or you can just name it to the name you want it to have with C010.

Command Name ---> Command number is accomplished with Command C012

If you know that entering a command name of "ABC123" causes a command to execute but you don't know what command number it is executing, you can use command C012 to find out.

How to Configure a Port as a Repeater

The RLC-3 controller supports a repeater on every port. This allows for multiple stand along repeaters operating at the same time, on the same controller. We will describe how to configure and setup port one as a repeater. Simply follow our example to configure other ports as repeaters.

Configure the port's connection:- C000 * 1 1*
     This command connects port 1's receiver to port 1's transmitter. When you do this ports 1 receiver will cause a PTT on ports 1 transmitter. You could call this putting it into repeater mode.

Configure the port's Hang timer:
- C020*016 200*
     This command set the hang timer to 200 * 10mS = 2 seconds.

Configure the port's ID'er:
- C085*1 1*
     This command enables the ider for port 1. The ID timer defaults to 10 minutes.

Programming in your ID:
     Macros 220, 228, 236, 244, 252, and 260 are set aside for your initial ID, rotating IDs and impolite IDs. See command C064 for more information about programming IDs.

Note: the IDs will automatically be sent to the right ports, so don't worry about the "message routing variable".

Configure the courtesy beep:
     The courtesy beep is already configured and stored in Macro 268. When you execute C268 you will get a "beep" at 500 Hz for 200mS. To program your own beeps refer to the earlier section "Beeps and Boops and Messages" or take a look at Command C040.

Configure the time-out timer:
     The time-out timer defaults to 3 minutes and is programmable with Command C020. You can change the time out message by re-programming macro 356 and the time out clear message by re-programming macro 364.

Now your port is configured as a repeater port.

Command Reference Section

This section contains in-depth descriptions of all of the commands in the controller. Most of them are organized by topic, so that related commands are next to each other. The commands you will need to get started are generally located closer to the front of the manual than commands you use less often. To quickly find a particular command, use the table of contents at the beginning of this manual.

Command Description: C000
Connect one Port to another Port

This command allows you to connect one radio port to another radio port. It is also used to put a port into "repeater mode", by connecting that port to itself. "Connecting a port" means that the audio in and keying source from each port become the audio out and PTT source for the other port. Connecting a port to itself makes the audio that comes in your repeater's receiver go out your repeater's transmitter, making it into a repeater. If you connect two different ports together, they will hear the activity from the other port.

Description	Command	Response
Connect Port	C000* X Y	X Connect Y ON

Note:
    If you want a one-way connection, where port A can monitor port B but port B can not hear port A, use command C001.

Parameters:
    - C000 is the default command name
    - X is the first port to connect
    - Y is the second port to connect

Default:
    - All port default as links

Example:
    Connect Port 1 to Port 4
        "C000 * 1 4" Voice response "1 Connect 4 On"

    Want port 1 as a repeater port
        "C000 * 1 1" Voice response "1 Connect 1 On"

Command Description: C001
Monitor one Port from another Port

This command allows you to monitor one radio port from another radio port.

Description	Command	Response
Monitor Port	C001* X Y	X MON Y

Parameters:
- C001 is the default command name
- X is the doing the monitoring of port Y
- Y is the port being monitored

Default:
- All port default as links

Example:
- Monitor Port 4 by Port 1
    - "C001 * 1 4" Voice response "1 MON 4"

Command Description: C002
Disconnect one Port from another Port

This command allows you to disconnect one radio port from another radio port.

Description	Command	Response
Disconnect Port	C002* X Y	X Connect Y OFF

Shortcut:
    If you want to break all of the connections to a port, check out C061.

Parameters:
    - C002 is the default command name
    - X is the first port to disconnect
    - Y is the second port to disconnect

Default:
    - All port default as links

Example:
    Disconnect Port 1 from Port 4
        "C002 * 1 4" Voice response "1 Connect 4 Off"

    Port 1 is currently a repeater port and you want the port configured as a link port.
        "C002 * 1 1" Voice response "1 Disconnect 1 Off"

Command Description: C003,C004
Recall a Port's Connections

This command allows you to find out where port X's receiver or transmitter is connected.

Description	Command	Response
Interrogate RX	C003* X	X Connect 1 .. 8
Interrogate TX	C004* X	X Connect 1 .. 8

Parameters:
   - C003 is the default command name. This command finds what transmitters are connected to receiver 'X' is routed to.
   - X is the receiver to recall the connections to

   - C004 is the default command name. This command finds what receivers are routed to transmitter 'X'
   - X is the transmitter to recall the connections to

Default:
   - All port default as links

Example:
   Port 1 is connected to ports 2 4 6 8
      "C003 * 1"   Voice response "1 Connect 2 4 6 8"

   Ports 1,3,5,7 are connected to port 2
      "C004 * 2"   Voice response "2 Connect 1 3 5 7"

Command Description: C005
Set Up a Port's Access Mode

This command allows you to set up a port's access mode.

Description	Command	Response
Access Mode	C005* X Y	X Mode(See Below)

Parameters:
- C005 is the default command name.
- X is the port number (1..8)
- Y is the port's access mode
-- 0 ==> No Access
-- 1 ==> COR Access
-- 2 ==> PL Access
-- 3 ==> COR and PL Access
-- 4 ==> COR or PL Access

Default:
- All ports default to COR access

Voice Response:

0 - No Access
1 - C O R
2 - P L
3 - C A P
4 - C O P

Example:
    You want to change port 5's mode to CAP (mode 3):

    C005 * 5 3   Voice Response "5 3"

Command Description: C006
Recall a Port's Access Mode

This command allows you to recall a port's access mode.

Description	Command	Response
Access Mode	C006* X	X Mode(See Below)

Parameters:
    - C006 is the default command name.
    - X is the port's access mode
        -- 0 ==> No Access
        -- 1 ==> COR Access
        -- 2 ==> PL Access
        -- 3 ==> COR and PL Access
        -- 4 ==> COR or PL Access

Default:
    - All port default to COR access

Voice Response:

    0 - No Access
    1 - C O R
    2 - P L
    3 - C A P
    4 - C O P

Command Description: C007, C008
Configure and Check DTMF Mute from a Selected Port

These commands allow you to program and recall whether DTMF mute is turned on or off for a selected port.

Description	Command	Response
Set Mute	C007* X Y	ON/OFF
Recall Mute	C008*	All Muted Ports

Parameters:
- C007 is the default command name.
- X is the requested port (1..8)
- Y is the Mute Enable/Disable flag
    - 1 ==> Enable DTMF mute on the selected port
    - 0 ==> Disable DTMF mute on the selected port

Default:
- DTMF Mute is Off

DTMF mute recall is provided to allow you to check what ports are Enabled for DTMF muting. If the port number is read back the port is configured for DTMF mute. If the response is "clear," no ports have DTMF muting enabled.

Command Description: C009
Recall Entire Controller's Crosspoint

This command allows you check the audio crosspoint conditions on all radio ports on the controller. This command will check the connected conditions and both show the crosspoint map on the RS-232 serial port, and will speak the conditions out the port that DTMF requested the conditions.

Description	Command	Response
Recall XPT	C009*	See Below

Parameters: None

Voice Response:
     The voice response will only speak if a receiver is connected on the selected port. If a receiver is connected to a port's transmitter, the controller will speak "RX connect TX" where RX and TX are the port numbers of the receiver and transmitter, respectively.

Voice Format:

1 Connect <TX1> <TX2> <TX3> <TX4> <TX5> <TX6> <TX7> <TX8>
2 Connect <TX1> <TX2> <TX3> <TX4> <TX5> <TX6> <TX7> <TX8>
3 Connect <TX1> <TX2> <TX3> <TX4> <TX5> <TX6> <TX7> <TX8>
4 Connect <TX1> <TX2> <TX3> <TX4> <TX5> <TX6> <TX7> <TX8>
5 Connect <TX1> <TX2> <TX3> <TX4> <TX5> <TX6> <TX7> <TX8>
6 Connect <TX1> <TX2> <TX3> <TX4> <TX5> <TX6> <TX7> <TX8>
7 Connect <TX1> <TX2> <TX3> <TX4> <TX5> <TX6> <TX7> <TX8>
8 Connect <TX1> <TX2> <TX3> <TX4> <TX5> <TX6> <TX7> <TX8>

Serial Format:
```
                    TX
               1  2  3  4  5  6  7  8
           1   .  .  .  .  .  .  .  .
           2   .  .  .  .  .  .  .  .
           3   .  .  .  .  .  .  .  .
RX         4   .  .  .  .  .  .  .  .
           5   .  .  .  .  .  .  .  .
           6   .  .  .  .  .  .  .  .
           7   .  .  .  .  .  .  .  .
           8   .  .  .  .  .  .  .  .
```

Command Description: C010
Re-Program Command Names

This command allows you to re-name the command names on the controller. The names can be from 1 to 6 digits in length.

Description	Command	Response
Re-name Command	C010* XXX YYYYYY	See Below

Shortcut:
    If you want to change the first few digits of a whole range of command names, check out command C062.

Parameters:
    - C010 is the default command name.
    - XXX is the command's number. It is the same as the last three digits of the command name as listed in the manual. Examples: the command number for this command (C010) is 010. For command C123, the command number is 123. The command number is always three digits. Renaming the command does not change the command number - you still use the command number as listed in the manual.
    - YYYYYY is the new command name.
      -- You only enter as many digits for the command name as the length you want the new name to be. You do not need to enter any leading digits for the command name.

      Acceptable entries:
      XXX Y   - New command name is 1 digit in length
      XXX YY   - New command name is 2 digits in length
      XXX YYY   - New command name is 3 digits in length
      XXX YYYY   - New command name is 4 digits in length
      XXX YYYYY - New command name is 5 digits in length
      XXX YYYYYY - New command name is 6 digits in length

Default:
    - Command names begin with C000 and end with C999

Voice Response:
    The voice response is XXX YYYYYY 'ED' [Extra Data]
      - [Extra data] is the amount of additional data needed for that command.

Example #1: Want to re-name command C013 to ABCD12
    1) Command Number is 013
    2) New command name is ABCD12
    3) C010 * 013 ABCD12
    4) Voice response: 13 ABCD12 ED 0

Example #2: You changed you mind. Now you want command number 013 (which we just
    renamed to ABCD12) to ABC123 instead.

    1) Command Number is 013
    2) New command name is ABC123
    3) C010 * 013 ABC123
    4) Voice response: 13 ABC123 ED 0

    Note that the current command name does not matter at all, only the command number
    (the last three digits of the command name in the manual) and the new name.

Command Description: C011, C012
Recall Information about a Command Name

This command allows you to recall certain attributes of the controller's command names.

Description	Command	Response
Name of Cmd	C011*XXX	See Below
Number of Cmd	C012*YYYYYY	See Below

Parameters:
- C011 is the default command name.
-- This command recalls the command name of the associated command number
- XXX is the command number ranging from 000-999

Voice Response:
The voice response is XXX YYYYYY 'ED' (Number of Digits of Extra Data)
- Extra data is the amount of additional data needed for that command.
- If the word "Variable" is spoken, the next number spoken is the minimum data accepted.

Parameters:
- C012 is the default command name.
-- This command recalls the command number for the associated command name
- YYYYYY is the command name with default command name of C000-C999

Voice Response:
The voice response is "Command Number (000-999)" is YYYYYY

Command Description: C013
Recall Radio Port Card Conditions

This command tells you what cards are either not installed on the controller, or have stopped responding to the system.

Description	Command	Response
Check Cards	C013*	See Below

Parameters:
    - C013 is the default command name.

Voice Response:
    The controller will speak the ports that are **not** on the system

    If a port is on the system, its port number will not be spoken.

    If a port is off the system, or there has been a failure the card number will be spoken. If a card is installed but this command says it is off of the system, try resetting the controller with command C035 and check it again

Command Description: C014..C019
Password Programming
Not Currently Active

Command Description: C020
Program a Selected Timer

This command allows you to program the controller's timer system.

Description	Command	Response
Program Timer	C020*XXX Y C020*XXX YY C020*XXX YYY C020*XXX YYYY	See Below

Parameters:
- C020 is the default command name.
- XXX is the selected timer to be programmed
- YYYY is the value to be programmed into the timer (0 to 9999)

Timer Numbers:

Message Start Delay Timer:
This timer sets the minimum delay between when a PTT goes active and when a voice message will start. It is intended to give link systems time for all the links to come up before speaking. It is not intended to set the delay between when a command is executed and when the response is spoken (that is still in development).
- This timer is programmed in 10mS increments from 001-9999
- If a timer value of 000 is entered, the timer will not work and will cause the voice to quit working.
- This timer defaults to 050 (500mS)

000 - Message Start Delay Timer, Transmitter 1
001 - Message Start Delay Timer, Transmitter 2
002 - Message Start Delay Timer, Transmitter 3
003 - Message Start Delay Timer, Transmitter 4
004 - Message Start Delay Timer, Transmitter 5
005 - Message Start Delay Timer, Transmitter 6
006 - Message Start Delay Timer, Transmitter 7
007 - Message Start Delay Timer, Transmitter 8

Courtesy Beep Delay Timer:
This timer specifies the minimum time between when a reciever unkeys and when its courtesy beep will be sent out connected repeater ports. The courtesy beep can also be delayed by other tones in the tone queues and the synthesized voice.
- This timer is programmed in 10mS increments from 001-9999
- If a timer value of 000 is entered, the transmitter will hang on the air forever.
- This timer defaults to 100 (1 Sec.)

008 - Courtesy Beep Delay Timer, Receiver 1
009 - Courtesy Beep Delay Timer, Receiver 2
010 - Courtesy Beep Delay Timer, Receiver 3
011 - Courtesy Beep Delay Timer, Receiver 4
012 - Courtesy Beep Delay Timer, Receiver 5
013 - Courtesy Beep Delay Timer, Receiver 6
014 - Courtesy Beep Delay Timer, Receiver 7
015 - Courtesy Beep Delay Timer, Receiver 8

Transmitter Hang Timer:
This timer holds the transmitter PTT active after the receiver goes inactive.
- This timer is programmed in 10mS increments from 001-9999
- If a timer value of 000 is entered, the transmitter will hang on the air forever.
- This timer defaults to 200 (2 Sec.)

016 - Hang Timer, Transmitter 1
017 - Hang Timer, Transmitter 2
018 - Hang Timer, Transmitter 3
019 - Hang Timer, Transmitter 4
020 - Hang Timer, Transmitter 5
021 - Hang Timer, Transmitter 6
022 - Hang Timer, Transmitter 7
023 - Hang Timer, Transmitter 8

DTMF Mute Timer:
This timer controls the amount of time the receiver entering DTMF stays muted. This timer needs to be short so the instances of "Voice Falsing" does not mute the audio too long. Voice falsing is the phenomenon that occurs when your voice sounds like a DTMF digit. If you set this timer too long and the DTMF decoder falses, you will have a long gap in your voice (for the length of this timer). The mute timer begins to run after the release of the DTMF key.
- This timer is programmed in 10mS Increments from 001-9999
- If a timer value of 000 is entered, your audio will be muted forever, so if you want it to be as short as possible, enter 001
- This timer defaults to 100 (1 Sec.)

024 - DTMF Mute Timer, Transmitter 1
025 - DTMF Mute Timer, Transmitter 2
026 - DTMF Mute Timer, Transmitter 3
027 - DTMF Mute Timer, Transmitter 4
028 - DTMF Mute Timer, Transmitter 5
029 - DTMF Mute Timer, Transmitter 6
030 - DTMF Mute Timer, Transmitter 7
031 - DTMF Mute Timer, Transmitter 8

Reserved Timers:
Do not mess with these timers. These timers affect the communications from the main board to the radio cards. Changing them will probably not help you but can cause the cards to be disabled (changing them back and resetting the controller will fix accidental changes).

032 - SPI Retry Timer, Port 1 (default value is 050, 500 ms)
033 - SPI Retry Timer, Port 2 (default value is 050, 500 ms)
034 - SPI Retry Timer, Port 3 (default value is 050, 500 ms)
035 - SPI Retry Timer, Port 4 (default value is 050, 500 ms)
036 - SPI Retry Timer, Port 5 (default value is 050, 500 ms)
037 - SPI Retry Timer, Port 6 (default value is 050, 500 ms)
038 - SPI Retry Timer, Port 7 (default value is 050, 500 ms)
039 - SPI Retry Timer, Port 8 (default value is 050, 500 ms)

040 - SPI Timeout Timer, Port 1 (default value is 700, 7 seconds)
041 - SPI Timeout Timer, Port 2 (default value is 700, 7 seconds)
042 - SPI Timeout Timer, Port 3 (default value is 700, 7 seconds)
043 - SPI Timeout Timer, Port 4 (default value is 700, 7 seconds)
044 - SPI Timeout Timer, Port 5 (default value is 700, 7 seconds)
045 - SPI Timeout Timer, Port 6 (default value is 700, 7 seconds)
046 - SPI Timeout Timer, Port 7 (default value is 700, 7 seconds)
047 - SPI Timeout Timer, Port 8 (default value is 700, 7 seconds)

I/O Polling Timer:
This timer determines how often the controller checks to see if any of the input lines have changed from high to low or low to high or if any analog alarm conditions have changed. If you want quicker response to changes, shorten this timer. If you don't want to hear about changes that happen more often than every minute or so, lengthen it to a minute. The default is one second.
- defaults to (100) 1 second

048 - I/O Polling Timer (100) 1 second

Courtesy Beep After Voice Timer:
This timer controls the amount of time the controller will wait after a voice message before sending a courtesy beep. The courtesy beep delay timers (timers 008..015) control how long after unkeying the controller will wait, but if they have already expired and the courtesy beep is waiting for the voice to finish, this timer will have an effect. An example of this is when you kerchunk a repeater after a long period of inactivity and then wait for the initial ID then the courtesy beep.
- This timer is programmed in 10mS Increments from 001-9999
- This timer defaults to 100 (1 Sec.)

049 - Courtesy Beep After Voice Timer, Transmitter 1
050 - Courtesy Beep After Voice Timer, Transmitter 2
051 - Courtesy Beep After Voice Timer, Transmitter 3
052 - Courtesy Beep After Voice Timer, Transmitter 4
053 - Courtesy Beep After Voice Timer, Transmitter 5
054 - Courtesy Beep After Voice Timer, Transmitter 6
055 - Courtesy Beep After Voice Timer, Transmitter 7
056 - Courtesy Beep After Voice Timer, Transmitter 8

Doug Hall RBI-1 Delayed Send Timer:
Buffers inside the RBI-1 overflow if it is sent too many changes too quickly. The RLC-3 avoids this potential problem by collecting all of the changes that occur quickly (such as within a macro) and sends the combined result of all of them only when no changes have been made for the length of this timer.
- This timer is programmed in 10mS Increments from 001-9999
- This timer defaults to 050 (1/2 Sec.)
057 - Doug Hall Delayed Send Timer

Impolite ID Timer:
This timer waits until either the timer expires or activity goes away before sending an ID.
- This timer is programmed in 1Sec increments from 001-9999
- If a timer value of 000 is entered, the controller will not interrupt a conversation to send an ID. Note that in this case, the 10 minute ID requirement could be broken.
- This timer defaults to 020 (20 Sec.)

070 - Impolite ID Timer, Transmitter 1
071 - Impolite ID Timer, Transmitter 2
072 - Impolite ID Timer, Transmitter 3
073 - Impolite ID Timer, Transmitter 4
074 - Impolite ID Timer, Transmitter 5
075 - Impolite ID Timer, Transmitter 6
076 - Impolite ID Timer, Transmitter 7
077 - Impolite ID Timer, Transmitter 8

Initial ID Timer:
This timer times the amount of inactivity before an initial ID is sent.
- This timer is programmed in 1Sec increments from 001-9999
- If a timer value of 000 is entered, the controller will never send an initial ID. Note that in this case, the 10 minute ID requirement could be broken.
- This timer defaults to 600 (10 Minutes)

078 - Initial ID Timer, Transmitter 1
079 - Initial ID Timer, Transmitter 2
080 - Initial ID Timer, Transmitter 3
081 - Initial ID Timer, Transmitter 4
082 - Initial ID Timer, Transmitter 5
083 - Initial ID Timer, Transmitter 6
084 - Initial ID Timer, Transmitter 7
085 - Initial ID Timer, Transmitter 8

Pending ID Timer:
This timer times inner activity ID timer so a proper Pending ID can be send during activity.
- This timer is programmed in 1Sec increments from 001-9999
- If a timer value of 000 is entered, the controller will never send a rotating ID. Note that in this case, the 10 minute ID requirement could be broken.
- If this timer is set to be longer or the same length as the initial id timer, the pending id will never be sent because the initial id takes priority. It should normally be set at least a minute shorter than the initial id to allow the pending id a chance to be sent, or the impolite id if there is activity, before the initial id timer expires.
- This timer defaults to 540 (9 Minutes)

086 - Pending ID Timer, Transmitter 1
087 - Pending ID Timer, Transmitter 2
088 - Pending ID Timer, Transmitter 3
089 - Pending ID Timer, Transmitter 4
090 - Pending ID Timer, Transmitter 5
091 - Pending ID Timer, Transmitter 6
092 - Pending ID Timer, Transmitter 7
093 - Pending ID Timer, Transmitter 8

Timeout Timers:
This timer times the how long each receiver has been active.   If the receiver is active longer than the length of this timer, it is disabled until it goes inactive, and its time out message (see Appendix D) is sent out all transmitters that are connected to it. It is reset and the time out clear message is sent when a timed out receiver goes inactive.
- This timer is programmed in 1 second increments from 001-9999
- If a timer value of 000 is entered, the controller will never time-out.
- This timer defaults to 180 (3 Minutes)

094 - Time Out Timer, Receiver 1
095 - Time Out Timer, Receiver 2
096 - Time Out Timer, Receiver 3
097 - Time Out Timer, Receiver 4
098 - Time Out Timer, Receiver 5
099 - Time Out Timer, Receiver 6
100 - Time Out Timer, Receiver 7
101 - Time Out Timer, Receiver 8

Dial Tone Timers:
These timers are used to limit how long the dial tone will run. The dial tone can also be stopped by other things, such as a DTMF character being entered on the port the dial tone is being set out of or the preaccess timer expiring (since indicating that a link has been preaccessed is what dial tone is used for most). If you want to generate dial tone that can't be stopped by any of these things, use command C040 and generate a two tone chord with frequencies of 350 and 440 Hz.
- This timer is programmed in 1Sec increments from 001-9999
- If a timer value of 000 is entered, this timer will never stop the dial tone.
- This timer defaults to 8 seconds

102 - Dial Tone Timer, Transmitter 1
103 - Dial Tone Timer, Transmitter 2
104 - Dial Tone Timer, Transmitter 3
105 - Dial Tone Timer, Transmitter 4
106 - Dial Tone Timer, Transmitter 5
107 - Dial Tone Timer, Transmitter 6
108 - Dial Tone Timer, Transmitter 7
109 - Dial Tone Timer, Transmitter 8

Preaccess Timers:
These timers control how long the "window" of access is between when you enter the preaccess code and when you have to enter a DTMF digit or be locked out. It starts running again as soon as each DTMF digit is released, and will lock you out if it expires. When it expires, it throws away whatever DTMF digits have been entered so far and won't accept any more commands until the controller is accessed again. It also stops the dial tone when it expires.
- This timer is programmed in 1Sec increments from 001-9999
- If a timer value of 000 is entered, this timer will never expire.
- This timer defaults to 8 seconds

110 - Preaccess Timer, Port 1
111 - Preaccess Timer, Port 2
112 - Preaccess Timer, Port 3
113 - Preaccess Timer, Port 4
114 - Preaccess Timer, Port 5
115 - Preaccess Timer, Port 6
116 - Preaccess Timer, Port 7
117 - Preaccess Timer, Port 8

User Timers:
These timers are not normally used by the controller. They are provided for your use. You can start them running by executing command C022 and stop them with C023 (or they will stop automatically when they expire). Also, when one of these timers expires, the corresponding special macro (see appendix D) is automatically executed. This allows you to start these timers when certain things in the controller happen, and do something when the timer expires. These timers are programmed in one second increments.

118 - User Timer 00
119 - User Timer 01
120 - User Timer 02
121 - User Timer 03
122 - User Timer 04
123 - User Timer 05
124 - User Timer 06
125 - User Timer 07
126 - User Timer 08
127 - User Timer 09
128 - User Timer 10
129 - User Timer 11
130 - User Timer 12
131 - User Timer 13
132 - User Timer 14
133 - User Timer 15

DTMF Interdigit Timers:
These timers are used to get rid of stray DTMF digits after several seconds without entering any more digits. For example, if you key and press a DTMF digit, then start talking, this timer will throw that digit away after a default of 5 seconds. That way if, after you talk a while, you try to enter a command, the digit you entered 30 seconds ago won't mess it up. Of course if you unkeyed during that time, all of the digits would be either executed or discarded anyway. This also reduces problems caused by voice falsing the DTMF decoder, by discarding the incorrectly received digits if no more digits are received during the length of this timer. This timer starts running when the DTMF digit is <u>released</u>, so you can hold a DTMF digit as long as you like without it being discarded.
- These timers default to 5 seconds

134 - DTMF Interdigit Timer, Receiver 1
135 - DTMF Interdigit Timer, Receiver 2
136 - DTMF Interdigit Timer, Receiver 3
137 - DTMF Interdigit Timer, Receiver 4
138 - DTMF Interdigit Timer, Receiver 5
139 - DTMF Interdigit Timer, Receiver 6
140 - DTMF Interdigit Timer, Receiver 7
141 - DTMF Interdigit Timer, Receiver 8

Reverse Patch Ring Timer:

This timer sets the maximum time between rings allowed for the reverse patch to work. If this timer expires between rings, the ring count starts over. This would keep the reverse patch from ever answering the phone.
- This timer is programmed in 1 second increments from 001-9999
- This timer defaults to 010

142 - Reverse Patch Ring Timer

Ping Cards Timer:
This timer controls how often the main processor checks to see if the link cards are still responding. You should not change the value of this timer. You can check to see which cards are responding with command C013.
- This timer is programmed in 1 second increments from 001-9999
- This timer defaults to 010

143 - Ping Cards Timer

DVR Start Recording Timer:
This timer sets the maximum time allowed after entering a command to start recording a DVR message and when you actually key up to start the recording. If you wait longer than this timer, it will not record. This is so a command to record a DVR message can not be executed and end up recording someone that keys up an hour later. If you start the recording with a DTMF digit, this timer will not have any effect.
- This timer is programmed in 1 second increments from 001-9999
- This timer defaults to 010

144 - DVR Start Recording Timer

DVR Record Length Limit Timer:
This timer sets the maximum length of message that can be recorded using the DVR. If you try to record a longer message, it will be truncated at this length. Of course, if you unkey, press a DTMF digit or the DVR runs out of memory before this time is up, it will quit recording sooner. You can set this timer to be relatively long while setting up the DVR, then shorter to keep people from leaving very long voice mail messages for people.
- This timer is programmed in 1 second increments from 001-9999
- This timer defaults to 030

145 - DVR Record Length Limit

Command Description: C021
Recall a Timer Value

This command allows you to recall the value of a programmed timer.

Description	Command	Response
Recall Timer	C021*XXX	See Below

Parameters:
   - C021 is the default command name.
   - XXX is the selected timer to be programmed (See Command C020 for Timers)

Advanced Command Description: C022
Restart a Selected Timer

This command allows you to reset and restart a selected timer back to its original value. The timer will then begin to run again from its original value.

Description	Command	Response
Restart Timer	C022*XXX	See Below

Parameters:
- C022 is the default command name.
- XXX is the selected timer to be programmed (See Command C020 for Timers)

Advanced Command Description: C023
Reset a Selected Timer

This command allows you to reset and cancel a timers operation.

Description	Command	Response
Reset Timer	C023*XXX	See Below

Parameters:
- C023 is the default command name.
- XXX is the selected timer to be programmed (See Command C020 for Timers)

Advanced Command Description: C024
Set Up RS-232 Serial Baud Rates

This command allows you to set up the baud rate for the RLC-3's main serial port that is typically connected to a serial terminal or computer and the serial ports on the radio cards that are primarily used for controlling remote base radios. See commands C032, C033, and C034 for more information about sending serial messages.

Description	Command	Response
Baud Rate	C024* P XXXXX	See Below

Parameters:
- C024 is the default command name.
- P is the serial port requested
    - 0 - Main RS-232 Port (on the motherboard)
    - 1 - Port 1 (on radio card 1, if installed)
    - 2 - Port 1 (on radio card 2, if installed)
    - 3 - Port 1 (on radio card 3, if installed)
    - 4 - Port 1 (on radio card 4, if installed)
    - 5 - Port 1 (on radio card 5, if installed)
    - 6 - Port 1 (on radio card 6, if installed)
    - 7 - Port 1 (on radio card 7, if installed)
    - 8 - Port 1 (on radio card 8, if installed)
- XXXXX is the actual baud rate (leading 0s are optional)
    - If P is 0:
        - You can enter any baud rate from 300-19200 including non-standard rates. The baud rate you enter will be rounded slightly to the nearest available rate, but should always be compatible with the actual rate selected.
    - If P is not 0:
        - You can enter any baud rate from 300-9600. The baud rate you enter will be rounded <u>down</u> to the nearest standard baud rate. The "standard" baud rates are 300, 600, 1200, 2400, 4800, and 9600 baud.

Default:
   9600 Baud rate selected

Command Description: C025
Sets the Time of Day Clock

This command allows you to set the time on the RLC-3 Clock.

Description	Command	Response
Set the Time	C025* XX YY Z	See Below

Parameters:
- C025 is the default command name.
- XX is the actual hours with leading zeros
- YY is the actual minutes with leading zeros
- Z is the AM/PM selection (1=PM, 0=AM)

Example:
Want to set the time to 3:25 PM

C025 * 03 25 1   Voice Readback "3 25 PM"

Command Description: C026
Recall the Time of Day Clock in Male Speech

This command allows you to read the Time of Day Clock. The readback is Male time reading. Refer to Command C025 for setting the clocks time.

Description	Command	Response
Recall the Time	C026*	Male Time

Parameters:
    - C026 is the default command name.

Command Description: C027
Recall the Time of Day Clock in Female Speech

This command allows you to read the Time of Day Clock. The readback is Female time reading. Refer to Command C025 for setting the clocks time.

Description	Command	Response
Recall the Time	C027*	Female Time

Parameters:
   - C027 is the default command name.

Command Description: C028
Sets the Date

This command allows you to set the date on the RLC-3 Clock.

Description	Command	Response
Set the Date	C028* XX YY ZZ D	See Below

Parameters:
- C028 is the default command name.
- XX is the month with leading zeros
- YY is the day of the month with leading zeros
- ZZ is the last two digits of the year
- D is the day of the week
    - Where
    1 = Sunday
    2 = Monday
    3 = Tuesday
    4 = Wednesday
    5 = Thursday
    6 = Friday
    7 = Saturday

Example:
    Want to set the date to January 2, 1994

    C028 * 01 02 94 7   Voice Response "January 2, 94 Saturday"

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Command Description: C029
Recall the Date

This command allows you to read the date stamp of the controller. The readback is Male date reading. Refer to Command C027 for setting the date.

Description	Command	Response
Recall the Date	C029*	Male Time

Note: if you want to recall the date as part of a message, you may want to try the variable words (Appendix B, words 500 and above). Speaking those words with command C036 will let you format the date readback any way you like it.

Parameters:
    - C029 is the default command name.

Voice Response: "This is <Month> <Day> <Year> <Day of Week>"

Command Description: C030
Send a CW Message

This command allows you to send a CW message. It will be sent to the ports that are in the audio routing variable at the time this command is executed (for more info, see Appendix A). The message will be sent at the speed and frequency that has been set up for the specific port with C042 and C043.

Description	Command	Response
Sends CW	C030* YY..YY	See Below

Parameters:
    - C030 is the default command name.
    - YY is the CW data, two digits per character (See Below)

CW Code Table

```
00  -  0      13  -  D      26  -  Q      39  -  AR
01  -  1      14  -  E      27  -  R      40  -  SPACE
02  -  2      15  -  F      28  -  S      41  -  PAUSE
03  -  3      16  -  G      29  -  T
04  -  4      17  -  H      30  -  U
05  -  5      18  -  I      31  -  V
06  -  6      19  -  J      32  -  W
07  -  7      20  -  K      33  -  X
08  -  8      21  -  L      34  -  Y
09  -  9      22  -  M      35  -  Z
10  -  A      23  -  N      36  -  /
11  -  B      24  -  O      37  -  .
12  -  C      25  -  P      38  -  ?
```

Note: This table is duplicated in Appendix C for ease of reference.

Command Description: C031
Send a DTMF Sequence

This command allows you to send DTMF tones. They will be sent to the ports that are in the audio routing variable at the time this command is executed (for more info, see Appendix A). See Command C044 to set up the length of the tones and pauses between tones.

Description	Command	Response
Sends DTMF	C031*YY..YY	See Below

Parameters:
- C031 is the default command name.
- YY is the DTMF data (See Below)

DTMF Code Table
- 00 - DTMF Digit 0
- 01 - DTMF Digit 1
- 02 - DTMF Digit 2
- 03 - DTMF Digit 3
- 04 - DTMF Digit 4
- 05 - DTMF Digit 5
- 06 - DTMF Digit 6
- 07 - DTMF Digit 7
- 08 - DTMF Digit 8
- 09 - DTMF Digit 9
- 10 - DTMF Digit *
- 11 - DTMF Digit #
- 12 - DTMF Digit A
- 13 - DTMF Digit B
- 14 - DTMF Digit C
- 15 - DTMF Digit D
- 16 - <Pause>

Advanced Command Description: C032
Send a Serial Message out the RLC-3 Port

This command allows you to send a custom message out the controller's serial port. If the message is entered with DTMF the serial message will only contain DTMF digits. If the message is entered using the RS-232 port, then the message will contain whatever characters you enter. This command is used to display serial error messages, among other things. The message will only be sent if you cause this command to be executed from the serial port or if you turn suppressed serial off with command C060, to minimize the amount of stuff being sent out of the serial port. If you want a message to be sent no matter what, use command C162.

Description	Command	Response
Sends Message	C032* Y .. Y	See Below

Parameters:
    - C032 is the default command name.
    - Y is the data to be sent over the RS-232 port
        -- The message length is limited to the maximum command length (about 100 characters) or if used in a macro, by the space left in a macro. If you need a longer message, split it up between several macros and use one macro to call the next macro in the sequence.

Voice response:
    There is no voice response for this command

Notes:
* To change the baud rate, see command C024.
* Serial output is normally queued (buffered) so that controller operation does not wait for the message to be sent before continuing. Queueing can be controlled with command C060.

Advanced Command Description: C033
Send a Serial Message out a Radio Card's Serial Port

This command allows you to send a custom message out of a radio card's serial port. If you are interfacing to a device that accepts serial communications with TTL (0 and 5V) levels, you need to remove U8 (if it is installed) on the radio card and install two jumper blocks on J5. If you want RS-232 voltage levels, you need to remove the jumper blocks from J5 and install a DS1275 IC in the socket for U8.

If the message is entered with DTMF the serial message will only contain DTMF digits. If the message is entered using the controller's main RS-232 port, then the message will contain whatever characters you enter. This command can be used to manually control HF radios (since the custom commands are not written yet) or to send messages to a serial printer, etc.

Description	Command	Response
Send Message	C033*P Y .. Y	See Below

Parameters:
- C033 is the default command name.
- P is the radio card to send the message out of
- Y is the data to be sent over the RS-232 port
    -- The message length is limited to the maximum command length (about 100 characters) or if used in a macro, by the space left in a macro. If you need a longer message, split it up between several macros and use one macro to call the next macro in the sequence.

Voice response:
    There is no voice response for this command

Note:
    To change the baud rate, see command C024. If you want to send characters that are not on the DTMF pad (if that is what you are using) or the keyboard (if you are controlling via the serial port), see command C034.

Advanced Command Description: C034
Send a Serial Message out a Radio Card's Serial Port

This command does the same thing as C033, but lets you send any serial character rather than just the ones you can find on your DTMF pad or keyboard. You specify the characters by entering their ASCII codes in decimal, three bytes per digit. An ASCII table showing some of the characters and their codes is included in appendix H.

Description	Command	Response
Send Message	C034*P YYY YYY ... YYY	See Below

Parameters:
- C034 is the default command name.
- P is the radio card to send the message out of
- YYY is the ASCII code of a digit to be sent out to the RS-232 port on a radio card. See appendix H for ASCII codes.

Voice response:
> There is no voice response for this command

Notes:
- Use C033 instead of this command if you can - it is a lot easier to use.
- To change the baud rate, see command C024.

Command Description: C035
Remotely Reset the Controller

This command allows you to remotely reset the RLC-3 controller. This does exactly the same thing as turning the power off and back on or pressing the reset switch on the board. It will not cause you to lose any of your programming - that is only possible by being at the site of the controller and following one of the initialization procedures described in Appendix E.

Description	Command	Response
Remote Reset	C035*	None

Parameters:
- C035 is the default command name.

Command Description: C036
Send a Voice Message

This command allows you to send a voice message out of the radio ports on the controller. This is handy for building voice messages for macro sequences, sending voice IDs, etc. Which ports will send the message is determined by the current audio routing variable at the time the command is executed (see Appendix A).

Description	Command	Response
Sends Voice	C036* YYY..YYY	See Below

Note: if you want the voice message to stop if someone keys up in the middle of the message (a polite voice message), see commands C063 and C064. These commands are often used for IDs.

Parameters:
    - C036 is the default command name.

    - YYY is the Voice word to be spoken
       -- See Voice Word Table for voice word numbers

Advanced Command Description: C037
Set Audio Routing Variable for Commands Inside a Macro

This command allows you to override the default message routing variable within a macro. It only remains in effect until the end of the macro or until C037 or C038 are executed, whichever comes first. Appendix A has more information about controlling where messages are sent. The most common use of this command is to send the audio generated by commands in a macro to a different combination of ports than it is normally sent to. An example of this is provided below.

Description	Command	Response
Sets Routing	C037*X..X	None

Parameters:
- C037 is the default command name.
- *X..X* is the list of ports the message is to be routed to.

Note:
    The changes made to the audio routing variable by this command affect all commands (including other macros) executed until the end of the macro containing this command, or until command C037 or C038 are executed again, whichever occurs first.

Example:
    You have repeaters on ports 1, 2 and 4. You want to make a recall time command that will speak the time out of all three repeaters whenever it is executed. Since command responses normally only go out of the port that entered the DTMF command, we need to use a macro and manually change the audio routing variable (with C037). We will use the command to recall the time in the male voice (C026) for this example. You could use any of the user macros (500..999), but we will use 500 for this example.
- First we will recall macro 500 to make sure that there is nothing stored in it that we want to keep: C054*500*.
- If it has something in it, we can delete it with C055*500*, or choose a different macro.
- Now we can append the commands we want to the macro. The first command we want the macro to execute will set the audio routing variable to ports 1, 2 and 4. This command is C037*124*. To append it onto the end of the macro we enter C056*500037124*.
- We then want the macro to recall the time (command C026). To append this onto the end of the macro we enter C056*500026*.
- Now we can cause the time to be recalled out ports 1, 2 and 4 by executing the macro: C500.
- If you want to rename this macro to "567", for example, do the following: C010*500567*. Now entering 567 and unkeying will execute the macro and cause the time to be spoken out ports 1, 2 and 4..

Advanced Command Description: C038
Kill All Responses Following This Command

This command kills all voice/cw responses beyond this point. This command designed for use within a macro. When multiple commands are executed inside a macro, the commands that are executed contain their own message responses. To keep from hearing all of the responses when the macro is executed, simple execute command C038 first, then all messages following that command are canceled. If you wants a message response to occur from within a macro, speak the response before you execute C038.

Description	Command	Response
Cancel Response	C038*	See Below

Parameters:
    - C038 is the default command name.

Notes:
    The changes made to the audio routing variable by this command affect all commands (including other macros) executed until the end of the macro containing this command, or until command C037 or C038 are executed again, whichever occurs first.

Example:
    Want to read the change the access mode of port 1 and speak a message indicating what you did.

1) Use a multiple command macro for this purpose
    C400 will be used to execute this sequence (Macro 400)

2) C005 is the Access mode change command
    Want to change the mode to COR and PL Access
        C005 1 2   "Port 1 COR and PL"

3) C036 is the Voice message speak command
    Want to speak "Repeater on PL"

4) Macro programming using a multiple command is needed
    C052 * 400 03 036 12 267 229 046 042 038 00 005 02 1 2* or <unkey>

5) The macro will now only speak the message "Repeater On P L" and not the mode change message "1 2"

Advanced Command Description: C039
Recall the Ports in the Current Audio Routing Variable

This command allows you to determine what ports audio is being sent out of without having a radio tuned to each of the transmitters. It speaks a list of numbers which represent the ports that are included in the audio routing variable at the time it is executed (see Appendix A for more information about audio routing variables). If it is executed directly, it will tell you what port you are executing commands from..

Description	Command	Response
Recall ARV	C039*	See Below

Example:
    You want to know what transmitters are hearing the courtesy beep that is generated when port 3's receiver unkeys. Solution: append this command to the end of the courtesy beep macro (270) for port three so it will speak the number of the ports that just heard the courtesy beep:

    C056*270 039

To delete command C039 from the courtesy beep macro when you are tired of hearing it, use command C058 and you will not have to delete the whole macro and program it again.

Command Description: C040
Send One, Two or Three Tone Chord

This command causes a tone "chord" to be sent out the ports specified by the routing variable (see Appendix A for information about the routing variable). A "chord" is composed of one, two or three tones which are generated simultaneously for a specified duration and followed by a specified pause. Most courtesy beeps use only one tone at time, although many have several tones in sequence. This type of courtesy beep would be generated by calling this command several times from a macro, sending a one-tone chord each time (see examples on the following pages). DTMF digits and dial tone are familiar two-tone combinations, and can be easily generated using this command.

Description	Command	Response
Single Tone	C040*TTT PPP FFFF	No Response
Single Tone	C040*TTTT PPPP FFFF	No Response
Dual Tone	C040*TTT PPP FFFF GGGG	No Response
Dual Tone	C040*TTTT PPPP FFFF GGGG	No Response

Parameters:
- TTT or TTTT is a number representing the length of the tone in 10mS increments. If you use four digits for the length of the tone, you must also use four digits for the length of the pause. The tone length is limited to 60 seconds (6000).
- PPP or PPPP is a number representing the length of the pause to follow the tone in 10mS increments. If you use four digits for the length of the tone, you must also use four digits for the length of the pause. The pause length is limited to 60 seconds (6000).
- FFFF is the frequency of the primary tone in hertz. All four digits must be entered.
- GGGG is the frequency of the secondary tone in hertz. All four digits must be entered. It is only used when you want both tones active <u>at the same time</u>, like a DTMF tone. If you want a beep at one frequency then a beep at another frequency, call this command twice from a macro and only specify one frequency each time.

Note about Courtesy Beeps

The RLC-3 courtesy beeps are not simply a programmable beep. When it is time to send a courtesy beep, the RLC-3 decides which ports should receive the courtesy beep, sets the audio routing variable to those ports (see Appendix A), and calls that port's courtesy beep automatic macro (see Appendix D). This makes it possible for you to make your courtesy beep do a lot more than just beep. If you call command C040 (send One, Two or Three Tone Chord), it will beep. If you call C040 more than once in the courtesy beep macro, it will beep more than once (examples below). If you call C036 (speak voice message), you will get a voice message for your courtesy beep. If you call C030, it will send CW. If you call C031, it will send DTMF. If you really want to, you could do several of the above.

Since most people want a sequence of beeps for their courtesy beep, we will provide some examples. Note that to get a single-beep courtesy beep, you just call C040 once from the courtesy beep macro. To get a three tone sequence, you call C040 three times within that macro. Below are some widely used courtesy beep sequences.

```
All Frequencies are in Hertz and times are in milliseconds
```

	Sequence #1			Sequence #2			Sequence #3		
	Frq A:	Frq B:	Dur	Freq A:	Freq B:	Dur	Freq A	Freq B	Dur
1)	0330	0000	100	0500	0000	100	0660	0000	100
2)	0330	0000	050	0500	0000	050	0660	0000	050
3)	0800	0000	100	0800	0000	100	0540	0000	100
4)	0500	0000	100	0500	0000	100	0750	0000	100
5)	0750	0000	120	0880	0000	080	1200	0880	080
6)	0440	0500	200	0440	0350	200	0000	0000	000
7)	0660	0880	100	0000	0000	000	0000	0000	000
8)	0440	0000	100	0000	0000	000	0000	0000	000
9)	0880	0000	100	0000	0000	000	0000	0000	000

Example:
    I want port 1's courtesy beep to be number 5 as listed above.

1) Locate the courtesy beep macro for port 1 in appendix D.
    - Slot 268 is Port 1's courtesy beep macro

2) C055 deletes the old contents of a macro
    C055*268*

3) C056 appends a command onto the end of a macro - we will do the first tone
    C056*268 040 012 000 0750*
        012 is the duration of the beep in 10 millisecond increments
        000 is the length of the pause in 10 millisecond increments
        0750 is the frequency of the tone in hertz

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4) C056 appends a command onto the end of a macro - the second tone
    C056*268 040 008 000 1200*
        008 is the duration of the beep in 10 millisecond increments
        000 is the length of the pause in 10 millisecond increments
        1200 is the frequency of the tone in hertz

5) C056 appends a command onto the end of a macro - the third beep - it is a dual tone beep
    C056*268 040 008 000 1200 0880*
        008 is the duration of the beep in 10 millisecond increments
        000 is the length of the pause in 10 millisecond increments
        1200 is the frequency of one tone in hertz
        0880 is the frequency of the other tone in hertz

6) Now when port 1's courtesy beep needs to be sent, the courtesy beep macro will call C040 three times to generate the three beeps.

Advanced Command Description: C041
Courtesy Beep Enable/Disable for a Selected Port
Not Yet Active

This command allows you to enable or disable a selected port's courtesy beep without the need to reprogram the beep when re-enabled.

Description	Command	Response
Control CB	C041*X Y	See Below

Parameters:
- C041 is the default command name.
- X is the selected port (1..8)
- Y is the Control number
    - 0 - Disables courtesy beeps always
    - 1 - Enables courtesy beeps only when port is looped back
    - 2 - Enables courtesy beeps only when port is not looped back
    - 3 - Enables courtesy beeps always

Advanced Command Description: C042
Set CW Speed for a Selected Port

This command allows you to set up the CW systems speed in words per minute. The maximum CW speed the FCC allows is 20 WPM, but the controller will handle 05..50 words per minute.

Description	Command	Response
CW Speed	C042*X YY	See Below

Parameters:
  - C042 is the default command name.
  - X is the selected port (1..8)
  - YY is the words per minute send value

Default:
  All ports default to 20 words per minute

Advanced Command Description: C043
Set CW 3-Tone Chord Frequencies for a Selected Port

This command allows you to set up the CW tone frequencies used by the CW system.

Description	Command	Response
CW Frequencies	C043*W XXXX YYYY ZZZZ	See Below

Parameters:
- C043 is the default command name.
- W is the selected port (1..8)
- XXXX is the first tone frequency (0000..9999) Hz
- YYYY is the second tone frequency (0000..9999) Hz
- ZZZZ is the third tone frequency (0000..9999) Hz

Default:
   Tone 1 is set to 1064 Hz.
   Tone 2,3 are set to 0000

Alternate Entries:
   If a single tone CW frequency chord is wanted, only enter 1 frequency
      - C043 * W XXXX

   If a 2 tone CW frequency is chord wanted, only enter 2 frequencies
      - C043 * W XXXX YYYY

   If a 3 tone CW frequency is chord wanted, only enter 3 frequencies
      - C043 * W XXXX YYYY ZZZZ

Advanced Command Description: C044
Set Up DTMF Regenerate Parameters
Not Currently Active

This command allows you to set up the DTMF regenerate parameters for each attached port. You may need to use this command to slow your DTMF tones down if a scanning DTMF decoder is on any of the attached systems that you want the RLC-3 to control.

Description	Command	Response
DTMF Parameters	C044*W XXXX YYYY	See Below

Parameters:
- C044 is the default command name.
- W is the selected port (1..8)
- XXXX is the length of the DTMF sequence in 10mS steps (0000..9999)
- YYYY is the pause between DTMF digits in 10mS steps (0000..9999)

Default:
    Both length and pause set to 100mS lengths

Command Description: C045..C049
Not Currently Active

Advanced Command Description: C050
Set Up Default Audio Routing Variables

This command allows you to configure where the voice is routed during serial programming, scheduler events, etc. By using this command, you can specify which of the 8 radio ports voice and tone responses will be routed to when commands are executed by one of the several sources listed. See Appendix A for more information about audio routing variables. Command C065 allows you to recall these settings.

Description	Command	Response
Voice Response	C050*X Y..Y	See Below

Parameters:
- C050 is the default command name.
- X is the default audio routing variable to change
    - 0 - commands entered from the serial port
    - 1 - commands executed by the scheduler
    - 2 - commands executed by the reset macro (see Appendix D for macros)
- Y is a list of the ports that the audio will be sent out of
    - If no digits are entered for Y, the audio will not be sent anywhere

Default:
    Voice response is disabled

Command Description: C051
Start Dial-Tone

This command allows you to generate a dial tone down for a given time down the port that requested this command. This command is used to give you an indication that access to the controller has been accomplished. This is not pre-access, simply dial tone generation. The dial tone is routed to the port that DTMF requested the command. This command is used in conjunction with the pre-access macros.

Description	Command	Response
Start Dial Tone	C051*	See Below

Parameters:
   - C051 is the default command name.
.

Killing the dial tone once it is running:

1) You can kill the dial tone with a DTMF digit on the port dial tone is present.

2) When the dial tone timer expires (See Command C020)

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Advanced Command Description: C052
Program a Multiple Command Macro Sequence

It is recommended that this command not be used because it is more difficult to use than the alternatives. It is retained for compatibility with older software versions. The recommended method of programming macros is to delete the macro to erase its current contents (with command C055), then repeatedly append that macro with the commands you wish for it to contain (with command C056).

This command allows you to program a multiple command macro sequence. The macros can call other macros, have additional data, but should not call themselves. The entry format must be followed in order for the macro to be executed correctly.

Description	Command	Response
Macro PGM	C052* (See Below)	See Below

Parameters:
    - C052 is the default command name.

Format: Seq. #1   Seq. #2   Seq. #3 ......
    C052 * VVV WW XXX YY Z..Z ... XXX YY Z..Z ... XXX YY Z..Z ...
        - VVV is the macro number for this sequence to be stored in
        - WW is the number of commands in the macro sequence
        - XXX is the command number within a macro
        - YY is the amount of additional data in
        - Z..Z is the additional data associated with command XXX
Example:
    Want to have the following commands stored in macro #123:
        - C004 with no additional data
        - C031 with 12 additional digits (1,2,3,4,5,6,7,8,9,8,7,6)
        - C040 with 10 additional digits (000,001,002,3)
        - C005 with no additional digits

    C052 * 123 04 004 00 031 12 123456789876 040 10 0000010023 005 00 *

- This sequence entered the 4 listed commands along with the needed additional data.
- It is very important to enter the correct command names, additional data and additional data counters. If you do not enter the correct data, the macro will no execute correctly.

Valid Macro Numbers:
   The controller supports 800 macro sequences in 2 groups.

   Group 1 macros number from 200..499. These macros are assigned to controller functions like ID's, Input/Output/Analog functions, and any internal operations needed.

   Group 2 macros number from 500..999. These macros are user macros that allow multiple commands, messages and operations for you to have access to.

Voice Response:
   The macro will execute the commands within the macro sequence. The voice response will be spoken for all the executed commands. If you executes a stop voice command (Future) the voice response will only be spoken up to the stop voice command.

Errors:
   When the macro is executed, and if any errors are encountered while the macro is executing, the errors will be spoken to inform you of the problem inside the sequence.

Command Description: C053
Program a Single Command Macro Sequence

This command allows you to program a macro to contain one command. It does exactly the same thing as deleting the macro with command C055, then appending it with C056. If you want a macro to contain more than one command, you can program the first command in the macro with this command, but you will have to use another command like C056 to append the rest of the commands in the macro onto the end.

Description	Command	Response
Macro PGM	C053* WWW XXX Z..Z*	OK

Parameters:
- C053 is the default command name.

    - WWW is the macro number for this sequence to be stored in
    - XXX is the command number to be executed by the macro
    - Z..Z is the additional data associated with command XXX

Example:
    Want to execute command C031 using macro 123
        - C031 with 20 additional digits (1,2,3,4,5,6,7,8,9,0,9,8,7,6,5,4,3,3,2,1)

    C053 * 123 031 12345678909876543321 *

Command Description: C054
Recall Macro Contents

This command recalls the contents of a macro so that you can find out what the macro is programmed to do. It does not execute the commands in the macro, only recalls them to the serial screen or speaks them with the voice synthesizer. The format of the response is explained below.

Description	Command	Response
Recall Macro	C054*XXX	OK

Parameters:
- C054 is the default command name.
- XXX is the macro number to recall

Format of the Voice Response:
 "M"   [macro number]
 "N"   [number of commands in the macro]
 "C"   [which command in the macro] [command number]
 "D"   [number of digits of data]   [the digits of data]
 repeat last two lines until all commands in macro have been recalled
 ? "percent"   how many percent full the macro is

Example: Recall Default Contents of Macro 200 (Command length not matched error handling macro):

You enter the command "C054*200"

The serial response is:
 Macro 200 contains 2 commands:
  #1 Command #032 with 31 digits of data: Command name length not matched
  #2 Command #036 with 09 digits of data: 133002028

The voice response is:
 "M200"   macro number 200
 "N2"   number of commands in the macro is 2
 "C1 32"   the first command in the macro is command number 032
        (send serial message)
 "D31" this command has 31 digits of data which are:
 "Command name length not matched"   (speaks each letter, with pauses for spaces)
 "C2 36"   the second command in the macro is command number 9
 "D9"   this command has 9 digits of data which are:
 "133002028" the words "Error Two-Hundred"

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Command Description: C055
Delete Macro

This command deletes a macro. If it is executed after it has been deleted, nothing will happen. There is no way to "undelete" a macro that has been deleted.

Description	Command	Response
Delete Macro	C055*XXX	OK

Parameters:
- C055 is the default command name.

Format:
C055 * XXX
- XXX is the command number of the macro to delete.

Command Description: C056
Append a Command to a Macro

This command allows you to add a command to a macro. If the macro was empty (contained no commands), it becomes the first command in the macro.

Description	Command	Response
Macro Append	C056* (See Below)	OK

Parameters:
>   - C056 is the default command name.

Format:
>   C056 * WWW XXX Z..Z ...
>>   - WWW is the macro number for this sequence to be stored in
>>   - XXX is the command number within a macro
>>   - Z..Z is the additional data associated with command XXX

Example:
>   Want to execute command C031 using macro 123
>>   - C031 with 20 additional digits (1,2,3,4,5,6,7,8,9,0,9,8,7,6,5,4,3,3,2,1)

>   C056 * 123 031 12345678909876543321 *

Command Description: C057
Copy a Macro

This command allows you to copy a macro. It deletes whatever used to be in the destination macro and replaces it with a copy of whatever is in the source macro.

Description	Command	Response
Macro Copy	C057*XXX YYY	OK

Parameters:
- C057 is the default command name.
- XXX is the number of the source macro
- YYY is the number of the destination macro

Advanced Command Description: C058
Delete a Command in a Macro

This command allows you to delete a command in a macro without deleting the whole macro. The commands inside of the macro are numbered 00, 01, 02... so the first command is numbered 00. It may be helpful to execute command C054 to recall the contents of the macro so that you know which command to delete.

Description	Command	Response
Delete CMD	C058*XXX YY	OK

Parameters:
- C058 is the default command name.
- XXX is the number of the macro
- YY is the number of command inside of the macro to delete (00, 01, 02...)

Advanced Command Description: C059
Insert a Command in a Macro

This command allows you to insert a command in a macro without deleting the following commands. This is useful for adding a command to the beginning or middle of a macro. The commands inside of the macro are numbered 00, 01, 02... so the first command is numbered 00. It may be helpful to execute command C054 to recall the contents of the macro so that you know where you want to insert the new command.

Description	Command	Response
Insert CMD	C059*XXX YY ZZZ DDD...	OK

Parameters:
- C059 is the default command name.
- XXX is the number of the macro
- YY is the where inside of the macro to insert the new command (00, 01, 02...)
     If YY is larger than the number of commands in the macro, the new command
will be appended to the macro.
- ZZZ is the command number of the command to insert
- DDD is the data for the above command

Advanced Command Description: C060
Set Up Serial Port

This command allows you to turn several options on or off for the serial port. Each of these options is discussed below.

The first is whether or not the serial port converts all characters that you type to upper case or not. The default is to convert them, because all of the default command names are in upper case (they must be to be executed by DTMF). Converting all of the characters makes it impossible to do a few things however, such as programming serial messages that contain lower case letters.

The second allows you to choose whether the controller will send a carriage return and line feed at the end of each line (the default) or just a carriage return. The latter might be useful in situations where the line feed messes up a modem or packet radio. Most communications programs can automatically add the line feeds back in when they receive a carriage return so that the screen will scroll, rather than printing each line over top of the last one.

The third determines whether serial messages that are generated by commands that are executed by DTMF are suppressed or printed. If they are suppressed (the default), the only serial messages that will be printed are: the reset/copyright message, serial responses to commands executed from the serial port (not DTMF), and serial messages sent with command C162.

The fourth is whether the serial is queued (buffered) or not. Normally it is buffered so that the controller can continue to run while the serial is sent in the background. Occasionally, usually for debugging purposes, you may want the serial to be sent before execution continues. In this case, you can turn queuing off. It automatically gets turned on whenever the controller is reset.

Description	Command	Response
Set up serial	C060*X Y	See Below
w/suppression	C060*X Y Z	See Below
w/queuing	C060*X Y Z Q	See Below
Default Setup	C060*0111*	See Below

Parameters:
- C060 is the default command name.
- X is 1 to make the serial port case sensitive (no automatic conversion to upper case)
    0 to make the serial port convert all characters entered to upper case
- Y is 1 to send line feeds (the default) or 0 to suppess them
- Z (optional) is 1 to suppress serial (the default) or 0 to send serial caused by commands
    entered from DTMF
- Q (optional) is 1 for queued serial (the default) or 0 to send it before continuing

Command Description: C061
Disconnect all Ports from a Radio Port

This command allows you to disconnect all of the other radio ports from one radio port with one command. Please note that if you execute this command for a repeater port, it will disconnect it from itself, breaking it out of repeater mode. To make it a repeater again, you will have to use command C000. If you only want to break some of the connections to a port, see commands C001 and C002.

Description	Command	Response
Disconnect Port	C061*X	

Shortcut:
    If you want to break all of the connections to several ports, list all of them. For example: C061*12345678* breaks every connection in the whole crosspoint.

Parameters:
    - C061 is the default command name
    - X is the port to disconnect all other ports from

Example:
    Disconnect all other ports from Port 4
        "C061 * 4"   Voice response "4 Clear"

Advanced Command Description: C062
Change the Beginning of Command Names

This command allows you to change the first one, two or three digits of the names of a range of commands. If you specify one digit, all of the command names in the range you specified will become four digits long. If you specify 2, they will be 5 long (and 3, 6). The last three digits of a command's name can not be changed with this command (see command C010). This is to avoid accidently assigning the same name to multiple commands.

Description	Command	Response
Start of Name	C062*XXX YYY Z	See Below
Start of Name	C062*XXX YYY ZZ	See Below
Start of Name	C062*XXX YYY ZZZ	See Below

Parameters:
- C062 is the default command name.
- XXX is the number of the first command in the range that you want to change
- YYY is the number of the last command in the range that you want to change
- ZZZ are the new first digits of the command names

Examples:
    You want to change the names of all of the commands in the controller to start with '#' instead of 'C' so that they can be executed from a 12-key touch tone pad:

    C062*000 999 #

    You want to make the names of commands 010 through 050 more difficult to guess by making them 6 digits long, starting with the digits 96C:

    C062*010 050 96C

Note:
    Any commands in the range that have names shorter than three digits long will have zeros added before their names to make them three digits long before this command changes the other digits. For example:

    C062*010 050 D

```
Changes  C010    to    D010,
         123     to    D123,
          A1     to    D0A1,
           #     to    D00#.
```

Command Description: C063
Send a Polite Voice Message

This command is identical to C036 except that if any receivers are active on a port where a word of this message is about to be spoken, the rest of the message will be thrown away. In other words, if you are keyed up, it will never talk over you. If you interrupt it, it will finish the word it is currently speaking and then throw the rest of the message away. This is commonly used for speaking scheduled messages, such as reading the time at the top of every hour. It could also be used for IDs, but if you want a CW ID to be sent when the voice ID is interrupted, use C064 instead.

Description	Command	Response
Polite Voice	C063* YYY..YYY	See Below

Parameters:
    - C063 is the default command name.

    - YYY is the Voice word to be spoken
        -- See Voice Word Table for voice word numbers

Command Description: C064
Send a Polite Voice Message and if Interrupted Execute Command

This command is identical to C063 except that if a receiver is active on the port the voice is being sent out of, it causes the polite message to not be spoken or to quit in the middle and it will cause another command to be executed. This is used to make a voice ID that gets interrupted cause a CW id to be sent instead (see the example below).

Description	Command	Response
Polite Voice	C064*XXX YYY..YYY	See Below

Parameters:
- C064 is the default command name.

- XXX is the command number to execute if the message is interrupted
- YYY is the Voice word to be spoken
  -- See Voice Word Table for voice word numbers

Example:
    You want to program a polite voice pending ID message for port 1 that will send a CW ID if it is interrupted. Since the first pending ID for port 1 is sent by macro 228, we will program that macro to execute command 064. We will tell command 064 to either speak the voice ID, or if it is interrupted, to execute the impolite ID (command number 260) instead. We will make the voice ID say the words "I D" with are word numbers 039 and 034 (you would want to change this - see Appendix B for other word numbers):

    C053*228 064 260 039 034

The above digits use command C053 to program macro 228 to execute command number 064. When command 064 executes, it checks for receiver activity. If the receiver is active, it executes command 260 (the impolite ID). Otherwise it speaks the voice message "ID".

You will also want to customize the CW ID in macro 260.

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Advanced Command Description: C065
Recall the Audio Routing Variable Defaults

This command allows you to determine what the audio routing variable will default to when commands are executed from the serial port, scheduler, etc. It is the companion command to C050.

Description	Command	Response
Recall ARV	C065*X	See Below

Parameters:
- - X is the default audio routing variable to recall
    - 0 - commands entered from the serial port
    - 1 - commands executed by the scheduler
    - 2 - commands executed by the reset macro (see Appendix D for macros)

Preaccess Commands

What preaccess is:

Preaccess is a method of specifying which controller you are trying to DTMF command that is used by several linking systems. A common configuration would be to enter the "*" key before commanding the local repeater, "#99" before commanding a distant controller via a link, and "#98" before commanding a different controller on the linking system. The advantage of requiring the user to "preaccess" a controller before commanding it is that you can use the same command names on each controller without confusion as to which one you are talking to. This is a very simplified description, but it should give you the idea.

What you need to know:

Because the preaccess system works quite differently from the way the RLC-3 normally works, there is a lot involved with changing back and forth. Commands C070 and C071 have been provided to make the conversion to preaccess easy and painless. If you have converted a port to preaccess and want to change it back, use command C072.

You always configure one port at a time for preaccess, so you can set up one port for preaccess and leave another port alone. This allows you to have a mixed system. This might be useful if you want to try out preaccess on one port without forcing all of the users of a repeater on a different port to change the way they do things. It also allows you to use the RLC-3 to interface between linking systems that do things differently.

Command Description: C070
Configure a Repeater for Preaccess

This command sets up a port to be a preaccess repeater. To execute commands from the repeater, key up, press the '*' key and enter the command. The command will be executed immediately, without waiting for you to unkey. This allows you to execute multiple commands in sequence without unkeying after each one. Also, when you pressed the star key, you were removed from any other repeaters or links you may have been connected to. In other words, the '*' puts you into a local control mode. This mode will expire if you unkey for 8 seconds (see command C076).

If you key this repeater and do not press the '*' key, you will not be in the local control mode and will be connected to other ports normally (see C000, C001 and C002).

Description	Command	Response
Rep Preaccess	C070*X	See Below

Format:
    - C070 is the default command name.
    - X is the port to make a preaccess repeater

Command Description: C071
Configure a Link for Preaccess

This command sets up a link to use the preaccess system. Links that are configured for preaccess will ignore any DTMF tones that are not preceeded by #ZZ where ZZ is the site access code you specify below. This allows commands to be sent down a linking system without every controller along the way trying to execute them, sending error messages, etc. To execute a command from such a link port, key up, enter #ZZ and the command. The command will be executed immediately, without waiting for you to unkey. This allows you to enter several commands in succession without unkeying after each one.

Description	Command	Response
Link Preaccess	C071*X Y ZZ	See Below

Format:
- C071 is the default command name.
- X is the port to set up as a preaccess link
- Y is 0 for no dial tone when accessed, 1 for dial tone
- ZZ is the last two digits of the site access code
    For example if ZZ is 99, the site access code will be #99.
    The site access code can be changed to anything up to six digits long by renaming the preaccess macro to that access code.

Advanced Command Description: C072
Disable Preaccess Requirement for a Port

This command allows you to turn off preaccess as set with C070 or C071. It sets the specified port back to factory defaults:
- EOF key is '*'
- Autoexecution is off
- Preaccess is off
- The port is a link

It also restores the preaccess macro for that port back to factory defaults:
- Empty (contents are deleted)
- Name is C??? where ??? is the macro number
- DTMF execution mask cleared

Description	Command	Response
Preaccess Off	C072*X	See Below

Format:
- C072 is the default command name.
- X is the port for which to turn the preaccess requirement off (1..8)

Advanced Command Description: C073
Recall Ports with Preaccess Requirement

This command allows you to determine which ports require preaccess.

Description	Command	Response
Preaccess	C073*	See Below

Format:
   - C073 is the default command name.

Advanced Command Description: C074
Allow Access To a Port that Requires Preaccess

This command allows commands to be executed on the port the command is executed from until the preaccess timer which it starts (see command C020 for more info on timers) runs out. It is usually called from the preaccess macro (see Appendix D) for that port so that when that preaccess macro is executed, it temporarily allows access to the rest of the commands in the controller.

Description	Command	Response
Allow Access	C074	See Below

Format:
  - C074 is the default command name.

Advanced Command Description: C075
Set Stop Access Conditions

A port that requires preaccess is said to be "accessed" when an access code has been received. Typically this access code is "*" for a repeater port or "#" and two digits for a link. There are four things that can stop access to a port that requires preaccess after you have entered the access code. When any of them occur, you must enter the access code before that port will accept commands again. The first is the preaccess timer. It starts running when you enter the access code and is re-started whenever you release a DTMF digit. It will never expire while you are holding down a DTMF digit. When no digits have been entered for the length of the timer, it locks up that port. The other three conditions are optional - you can choose whether or not they will cause a port to be locked up.

- A command is executed or tries to execute and causes an error. If this condition is enabled, you will not be able to execute the access code once, then multiple commands. You will be able to enter the access code, one command, access code, one command...

- An error occurs because the digits entered are not a valid command name. If you make a mistake and this condition is enabled, you will have to enter the access code before you can try again.

- DTMF digits have been entered since the access code was entered and you unkey. This condition doesn't care how many commands you enter or whether they were valid or not; if you enter anything and unkey, you will be forced to enter the access code again.

This command allows you to choose whether these optional conditions will cause the ports to be locked up or not. Please note that the timer will always lock up the port after a period of no DTMF tones, these conditions just provide extra security if you want it.

Description	Command	Response
Allow Access	C075*PXYZ	See Below

Format:
- C075 is the default command name.
- P is the port for which to set the stop access conditions (1..8)
- X is 1 to enable / 0 to disable stopping access when a command is executed
- Y is 1 to enable / 0 to disable stopping access when an invalid command is entered
- Z is 1 to enable / 0 to disable stopping access when the COR drops after a DTMF tone has been entered

Advanced Command Description: C076
Recall Stop Access Conditions

This command allows you to recall the conditions that will stop access on a port. See Command C075 for descriptions of the conditions.

Description	Command	Response
Allow Access	C076*P	See Below

Format:
- C076 is the default command name.
- P is the port for which to recall the stop access conditions (1..8)

Advanced Command Description: C077
Isolate a Port from the Rest of the System

This command breaks the audio and ptt links between the specified port and all other ports in the system until the preaccess timer (which it starts) runs out. It temporarily overrides but does not change the crosspoint connections you may have set with command C000 and C001. It is useful for isolating a port while you enter local control commands without the tones going down any connected links. It is usually called from the preaccess macro of a port configured as a repeater. This macro is usually named '*', the local control key.

Description	Command	Response
Allow Access	C077*X	See Below

Format:
- C077 is the default command name.
- X is the port for which to allow access (1..8)

Advanced Command Description: C078
Set the Force-Execution Digit for a Port

This command allows you to specify which DTMF digit will be used to force a command to be executed without unkeying. It will also be used to separate the command name from the data you provide. It defaults to '*' for all ports.

Description	Command	Response
Change EOF	C078*X Y	See Below

Format:
- C078 is the default command name.
- X is the port for which to change the force-execution digit
    - 1..8 indicate the corresponding port
    - 9 indicates the serial port
- Y is the new digit to use

Notes:

Trying to change the digit to what it already is will cause an "extra data too short" error message because when you enter it, the command will execute too soon. This error message can be ignored, because the digit is already what you were trying to change it to.

When changing the digit from the serial port, any key on the keyboard can be used. If you set the digit for one of the ports to a non-dtmf digit, that port will be forced to unkey to execute commands. This is not recommended. Program the force-execution digits for 1..8 to a valid DTMF character.

Advanced Command Description: C079
Recall the Force-Execution Digit for a Port

This command allows you to recall which DTMF digit will be used to force a command to be executed without unkeying. It will also be used to separate the command name from the data you provide. It defaults to '*' for all ports.

Description	Command	Response
Recall EOF	C079*X	See Below

Format:
- C079 is the default command name.
- X is the port for which to change the force-execution digit
    - 1..8 indicate the corresponding port
    - 9 indicates the serial port

Advanced Command Description: C080
Set Automatic Force-Execution Digit Entry for a Port

This command allows you to turn on and off the requirement that a command name be followed by a "*" (or other digit if it the force-execution digit has been changed).

When automatic "*" entry is turned off (the default), commands that do not need any data (C009 such as recall whole crosspoint) must be followed by a "*" or you must unkey to make them execute. When this command is used to enable automatic entry of the "*" key, the command will be executed as soon as the last digit of the command name is entered.

Commands that require data after the command name (such as this one) normally require you to press the "*" key after the command name before the data. When automatic "*" entry is turned on, this is unnecessary. It is still necessary, however, to press the "*" key or unkey your radio after the data has been entered. This is necessary because many commands that require data will accept variable amounts of data and the controller needs some way to know when it has all been entered.

It should be noted that when automatic "*" entry is turned on, there are some limitations in what command names can be accessed. If one command name is the same as the first few digits of another command name, you will not be able to access the longer one. For example, if you have renamed the recall time of day command to "1" and the recall date command to "12", when you try to recall the date by pressing "12" the controller will see the "1", notice that is matches the name of the read time of day command and execute it. When it sees the "2", it will not know that it belongs with the "1" to form the command "12", so it will not recall the date. This limitation is the reason that the controller defaults to requiring you to manually enter the "*" key.

Description	Command	Response
EOF Required?	C080*X Y	See Below

Format:
- C080 is the default command name.
- X is the port for which to set the automatic "*" entry (1..8)
- Y is 0 to turn the feature off (the default), 1 to turn it on

Advanced Command Description: C081
Recall Automatic Force-Execution Digit Entry for a Port

This command allows you to recall whether or not the requirement that a command name be followed by a "*" (or other digit if it the force-execution digit has been changed) is turned on. See C080 for more information.

Description	Command	Response
EOF Required	C081*X	See Below

Format:
- C081 is the default command name.
- X is the port for which to recall the automatic "*" entry (1..8)

The Scheduler

How the Scheduler Works:

The scheduler provides you with the ability to have up to 100 events occur automatically at hourly, daily, weekly, monthly or yearly intervals. The information used to store when event is supposed to occur and what it is supposed to do is stored in a "scheduler slot". The information about each event you want to set up must be stored in a different scheduler slot. You can change the contents of a scheduler slot by simply programming something different into that slot. Each event can call one command or user macro. If you call a macro, you can execute as many commands as you want in response to that scheduler event. You can use command C084 to keep a scheduled event from happening (disabling it) and to re-enable it later. Programming is explained in the command descriptions.

Command Description: C082
Set Up a Scheduler Event

This command sets up when a scheduler event will occur and what will happen at that time.

Description	Command	Response
Hourly Event	C082*XX YYY MM	See command C083
Daily Event	C082*XX YYY HH MM P	See command C083
Weekly Event	C082*XX YYY W HH MM P	See command C083
Monthly Event	C082*XX YYY DD HH MM P	See command C083
Yearly Event	C082*XX YYY NN DD HH MM P	See command C083

Format:
- C082 is the default command name.
- XX is the number of the scheduler slot to set up [00..99]
- YYY is the number of the command to be executed by the scheduler
    Note: The command that the scheduler executes must not require any data (like is normally entered after the "*" key), because there is no way to supply that data. If you want the scheduler to execute a command that requires data, you must make the scheduler call a user macro, then program that macro to call the command with the appropriate data.
- MM is how many minutes after the hour the event will occur
- HH is the hour that the event will occur (12 hour time)
- P is 0 to indicate A.M. or 1 to indicate P.M.
- W is the day of the week
    1 = Sunday
    2 = Monday
    3 = Tuesday
    4 = Wednesday
    5 = Thursday
    6 = Friday
    7 = Saturday
- DD is the day of the month
- NN is the month of the year

Note about audio responses:
    The default audio routing variable for commands executed by the scheduler is set by command C050. If you want to change where the audio goes, either change the default with command C050 or change it inside of a macro with command C037. See appendix A for more information about audio routing variables.

Example #1 (hourly):

You want to have the controller speak the time (command C026) at the top of every hour. We will program an hourly event in scheduler slot 00 to execute command number 026 when the minutes are 00:

C082*0002600*

Example #2 (daily):

Next you decide that you don't want it to recall the time at night, just from 8 A.M. through 10 P.M. This is really two events, one to enable it in the morning, another to disable it at night. The command to enable or disable scheduler slots is C084. Because C084 requires data after the command name, we will have to call it from a macro. First we will write the macros to enable and disable reading the time, then we will make the scheduler call those macros.

C053*500084001*   make macro 500 enable scheduler slot 00
C053*501084000*   make macro 501 disable scheduler slot 00
C082*0150007300* program scheduler slot 01 to execute command 500 at 7:30 A.M.
        every day
C082*0250110301* program scheduler slot 02 to execute command 501 at 10:30 P.M.
        every day

Example #3 (weekly):

Friday (day 6 to the scheduler) at 5:00 P.M. you want the message "TGIF" (word numbers 050, 037, 039, 036) spoken out all ports on the controller. Again, we need to use a macro (number 502 for this example) to set the audio routing mask to all ports and speak the message:

C053*50203712345678*   program macro to set audio routing variable to all ports
C056*502036050037039036*   append macro to speak voice message "TGIF"

Now we will program weekly scheduler event 03 to execute macro 502:

C082*03502605001*

Example #4 (monthly):

One minute after midnight on the first day of each month, you want the controller to speak "this is" then the name of the month out ports 1, 3, and 5. The word numbers for "this is" are 353 and 205. We will use the variable word number 509 to speak the current month (see appendix B for word numbers). To program macro number 503, we enter:

C053*503037135*　　　program macro to set audio routing variable to ports 1, 3 and 5
C056*503036353205509*　　append macro to speak "this is" and the name of the month

Now we will make scheduler slot 04 call macro 503 monthly on the first day of the month at 12:01 A.M.

C082*045030112010*

Example #5 (yearly):

You want to turn DTMF mute off on the repeater on port 1 at 10 minutes after noon on April fools day. First we program macro 504 to call command 007:

C053*50400710*

Then we program scheduler slot 05:

C082*05504040112101*

Command Description: C083
Recall a Scheduler Event

This command recalls when a scheduler event will occur and what will happen at that time.

Description	Command	Response
Recall Event	C083*XX	See Below

Format:
   - C083 is the default command name.
   - XX is the number of the scheduler slot to recall [00..99]

Explaination of the voice response:
   "S ?? On/Off"   Recalling Scheduler slot ?? and stating whether it is enabled (see
            command C084).
   "C ???"   When the scheduler event occurs, it will execute command number ???.
   "Frequency ?"   How often the event happens
            4 - hourly
            3 - daily
            2 - weekly
            1 - monthly
            0 - yearly
From this point on, the response depends on the frequency.
   Hourly:
      "?"   How many minutes after the hour the event happens.
   Daily:
      "Time ????"   What time of day the event happens.
   Weekly:
      "????"   The day of the week.
      "Time ????"   What time of day the event happens.
   Monthly:
      "D ?"   What day of the month the event happens.
      "Time ????"   What time of day the event happens.
   Yearly:
      "????"   The month of the year that the event happens.
      "D ?"   What day of the month the event happens.
      "Time ????"   What time of day the event happens.

Command Description: C084
Enable/Disable a Scheduler Event

This command allows you to temporarily disable a scheduler slot, then re-enable it later without having to reprogram it from scratch.

Description	Command	Response
En/Disable	C084*XX Y	See Below

Format:
- C084 is the default command name.
- XX is the number of the scheduler slot to recall [00..99]
- Y is 1 to enable the event, 0 to disable it

ID Control

How the IDs Work:

Whenever an ID needs to be sent, the appropriate automatic macro is called. You program your IDs by programming those macros (see appendix D for macro definitions). The following group of commands allow you to disable IDing for a port or change how the periodic IDs are sent.

Advanced Command Description: C085
Enable/Disable IDing a Port

This command allows you to enable or disable the IDing functions for a port. Normally all ports are IDed, including link ports. Often this is not desired. This command allows you to turn off the IDing functions.

Description	Command	Response
En/Disable	C085*X Y	See Below

Format:
- C085 is the default command name.
- X is the port for which to enable or disable the IDs (1..8)
- Y is 1 to enable IDs, 0 to disable them
    The default is enabled

Note: if you only want to disable some of the IDs for a port, keeping the pending IDs but not the initial ID, for example, just delete the ID macro that you don't want to do anything (see appendix D for macro definitions).

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Advanced Command Description: C086
Recall Which Ports have IDs Enabled

This command lists the ports that have IDing enabled. If all ports do, it speaks "12345678".

Description	Command	Response
En/Disabled?	C086	See Below

Format:
    - C086 is the default command name.

Advanced Command Description: C087
Set Random or Rotating Pending IDs

This command allows you to select whether the four pending IDs for a port will be sent in random order or whether they will just be rotated through (0, 1, 2 ,3, 0, 1, ...).

Description	Command	Response
Rotate/Random	C087*X Y	See Below

Format:
- C087 is the default command name.
- X is the port for which to enable or disable the IDs (1..8)
- Y is 1 for random, 0 for rotating (default is rotating)

Advanced Command Description: C088
Recall Random or Rotating Pending ID Selection

This command allows you to recall which ports rotate through the pending IDs (0, 1, 2 ,3, 0, 1, 2, 3, 0, 1, 2, ...) and which ones select them in random order. Voice response will list the ones that rotate, the others are random.

Description	Command	Response
Rotate/Random	C088	See Below

Format:
    - C088 is the default command name.

Command Description: C089
Not Currently Used

The I/O Board

About the I/O Board:

The RLC-3 will support up to two I/O boards. Each I/O board provides eight logical inputs, eight logical outputs and eight analog input lines. They are all handled totally separately in software; each command applies to only one of the three types of lines. Each type will be described below.

Please note that you can control how often the RLC-3 checks the input line and analog alarms by using C020 to change the reset value of timer 034. The default is to check the alarms once per second.

Logical Input Lines:

The logical input lines are used to detect whether a line is "high" or "low". High means that the voltage read by that line is above approximately 2.5 volts. Low means that the voltage is below about 1 volt. The range between 1 volt and 2.5 volts is indeterminate. If the line is not connected, a 47K internal pullup resistor to 5 volts will make the line read high. This pullup allows you to easily read whether a switch is open or closed. Simply connect the switch between the input line and ground. If the switch is closed, the input will read low. If the switch is open, the pullup resistor will make the input line read high. The input line can handle voltages up to +40 volts. Do not apply negative voltage to an input line.

Input lines can be used in three ways.
*   Command C090 can read an input line and tell you whether it is high or low.
*   There is also a way to assign a custom voice message to each state of an input line, such as "door open" and "door shut" (instead if high and low). To do this, program the voice messages you want to be spoken for the high and low states into the input line macros (see automatic macros starting with number 324 in appendix A). You can then cause the appropriate message to be spoken by executing command C091.
*   If you want a message to be spoken whenever an input line changes from high to low or low to high, you can cause the macros you programmed in the step above to automatically be executed at those times by enabling an "input line alarm" with command C092. You could use this feature along with a door switch to tell you when someone opens or closes a door.

Logical Output Lines:

The logical outputs are "open collector" outputs. That means that they can connect the output line to ground (turn it on) or disconnect it (turn it off). The output lines never output any voltage. The way they are commonly used is to connect one lead of the coil of a relay (or whatever else you want to control) to 12 volts and the other lead to an output line. When the output is turned on and applies a ground, the coil of the relay will be energized and will turn the relay on. The output line can "sink" (apply a ground of) about 150 milliamps.

Connecting an output line directly to a power supply and turning it on will destroy the output driver IC. Make sure that whatever you are turning on and off draws less than 150mA.

The output lines can be turned on and off with C093 and C094. You can recall whether a line is currently on or off with command C095. If you want to speak a custom message when you turn an output on or off, program one of the user macros to speak the message you want, execute C038 (to suppress the rest of the voice responses), and then turn the output line on or off.

Analog Input Lines:

The analog input lines are designed to read a voltage on one of two ranges: 0 to 5 volts, or 0 to 25 volts. You can select which range is used with the DIP switches labeled "Voltage Divider" on the I/O board itself. If the switch is on, you will be using the 0 to 25 volt scale, because it "divides" the input voltage by 5. No matter which way the switch is set, most of the discussions about the analog inputs will speak of the the voltage input as being 0 to 5 volts since the voltage divider is in hardware and the software doesn't know whether the divider is turned on or not. If you do have the divider turned on, just remember that 5 volts to the software means 25 volts to you.

The RLC-3 provides a lot of flexibility in how it reads the input lines. Unfortunately, this also makes things a little bit complicated. Charts have been provided so that you can use the input lines without understanding how all of the math works, but if you have a unusual application, the RLC-3 can handle that as well. The following paragraphs explain what some of the options are when reading analog lines. The way you select from those options is described with the commands themselves.

"Resolution" refers to how many digits after the decimal place you want to know about. Temperature is usually read to the nearest degree, zero digits after the decimal. When reading a battery or power supply's voltage, you probably want to hear more than "thirteen volts" or "fourteen volts", something like "thirteen point six volts". To obtain this kind of reading, you would specify one digit after the decimal point.

The "conversion ratio" specifies how the controller interprets the voltage it detects. It could also be called the "scale" or "meter faceplate". If you are measuring wind speed, you may want a reading that varies from zero to 100 MPH. If wind direction, zero to 360 degrees. If pH, zero to 14. If temperature, way below zero to a hundred degrees or more. No matter what scale you want the reading to use, the voltage going into the analog line must be between 0 volts and 5 volts (or 0 and 25 with the voltage divider on). If you have a sensor to measure something in the physical world that can provide a voltage that varies between 0 volts and 5 volts (or 25...), you can set up the conversion ratio to handle it. The point of this discussion is to make it clear that the controller does not care what the real-world quantity is, it just needs a variable voltage and the proper conversion ratio, and it can handle it. You tell the RLC-3 what the conversion ratio is by specifying two points:

The first is what real world quantity would cause the sensor to output 0 volts. In many cases this is zero. For example, if you are using a small motor with a propeller to detect

wind speed and the wind is not blowing, you will get 0 volts. But what about temperature? If our sensor outputs 0 volts for zero degrees, how would we get negative temperature readings? The analog lines can only accept positive voltages. The answer is that we use a temperature sensor that outputs about 2.5 volts at zero degrees, less than that when below zero and more than that when above zero. So our first conversion point for temperature says that it would have to be 460 degrees below zero to get 0 volts out of the sensor.

The second point we set specifies what real world quantity would cause the sensor to output 5 volts (or 25 with the voltage divider turned on). If your wind speed detector outputs 5 volts when the wind is blowing 150 MPH, this point would be 150. For the temperature sensor we use (the LM335), it would have to be 440 degrees out to get 5 volts out of the sensor.

"Calibration" refers to correcting for small errors in a reading. If your the controller tells you it is 85 degrees when it is 88, you can calibrate it to correct for the small error. If it is way off, you probably have the conversion set wrong.

You can also set "analog alarms". These will cause a macro to be executed whenever the value read on one of the analog lines goes above or below a preset value. See commands C104..C07 for more information.

If you want to use an analog input to control a rotor, see appendix F.

Command Description: C090
Read Whether Input Line is High or Low

This command allows you to read the input lines on an I/O board. If they are not hooked up they will read high (they have internal pullups).

Description	Command	Response
Read Input	C090*X Y	See Below
Read Inputs	C090*X Y..Y	See Below

Note: to provide customized messages for the input lines, see command C091.

Format:
- C090 is the default command name.
- X is the I/O board number (1..2)
- Y is the input line number (1..8)
    - Note: Multiple input lines can be read with one call to this command by entering more than one port number here.

Command Description: C091
Execute Input Line High or Low Macro

This command is similar to C090. The difference is that instead of speaking the word "high" or "low", the high or low internal macro for that input line will be executed. This allows you to program custom messages such as "door open" and "door shut". See Appendix D for to find the macro numbers for each input line.

Description	Command	Response
Read Input	C091*X Y	See Below
Read Inputs	C091*X Y..Y	See Below

Format:
- C091 is the default command name.
- X is the I/O board number (1..2)
- Y is the input line number (1..8)
    Note: Multiple input lines can be read with one call to this command by entering more than one port number here.

Command Description: C092
Enable/Disable Input Line Alarm

This command allows you to turn on input line alarms that will occur whenever an input line goes high or low. When the alarm occurs, it will execute the input line high or low macro. Note that these are the same macros that get executed by C091 whenever the input line is read. The high and low alarms can be enabled or disabled separately.

Description	Command	Response
Input Alarms	C092*X Y Z Q	See Below

Format:
- C092 is the default command name.
- X is the I/O board number (1..2)
- Y is the input line number (1..8)
- Z is 1 for the high alarm, 0 for the low alarm
- Q is 1 to enable the alarm, 0 to disable it

Note:
There is currently no command recall whether the input line alarm is turned on or off.

Command Description: C093
Turn Output Line On

This command allows you to turn an output line on. The outputs are active low open collector drivers, so on means that they apply a ground to that output. Off means that the output is open, or not hooked to anything.

Description	Command	Response
Output On	C093*X Y	See Below
Outputs On	C093*X Y..Y	See Below

Note: to provide customized messages when turning output lines on or off, use a macro that both executes this command and the speak voice message command (C036).

Format:
- C093 is the default command name.
- X is the I/O board number (1..2)
- Y is the output line number (1..8)
     Note: Multiple output lines can be turned on with one call to this command by entering more than one port number here.

Command Description: C094
Turn Output Line Off

This command allows you to turn an output line off. The outputs are active low open collector drivers, so on means that they apply a ground to that output. Off means that the output is open, or not hooked to anything.

Description	Command	Response
Output Off	C094*X Y	See Below
Outputs Off	C094*X Y..Y	See Below

Note: to provide customized messages when turning output lines on or off, use a macro that both executes this command and the speak voice message command (C036).

Format:
- C094 is the default command name.
- X is the I/O board number (1..2)
- Y is the output line number (1..8)
    - Note: Multiple output lines can be turned off with one call to this command by entering more than one port number here.

Command Description: C095
Recall Whether Output Line is On or Off

This command allows you to read the output lines on an I/O board. This command will tell you whether the output line is turned on or off.

Description	Command	Response
Recall Output	C095*X Y	See Below
Recall Outputs	C095*X Y..Y	See Below

Format:
- C095 is the default command name.
- X is the I/O board number (1..2)
- Y is the input line number (1..8)
    Note: Multiple output lines can be recalled with one call to this command by entering more than one port number here.

Note:
    To provide a customized message when an output line is turned on or off, call C093 or C094 from a macro that also speaks a voice message. There is no easy way to get a customized message to recall whether a line is on or off at the current time without turning it on or off again. If you really need custom recall messages and you are *very* familiar with macro programming, read the following, otherwise don't bother. The idea is to use a macro to call the output line on and off commands. Also in that on/off macro, call the program-single-command-macro command and program another macro (we will call it the recall macro) to speak the appropriate recall message. That recall macro could then be executed to find out whether the output line was turned on or off last. In other words, we would use the on and off macros to program the recall macro. Whichever on/off macro was executed last would have programmed the recall macro last, making it contain the appropriate message. If you didn't understand all of this, don't worry about it, use this command, and wait for a later software version that will make all of this easier.

Command Description: C096..C098
Pulse Output Lines
Not Finished Yet

These commands will allow you to pulse an output line a specified number of times. They will also allow for selecting pulsing low or high and the pulse rate. If you have special needs in this regard, please contact us by mail or fax with your request.

Command Description: C100
Read Analog Input Line

This command allows you to read the analog input lines on an I/O board. The number that is read back will depend on three other things: the precision used (set with command C101), the conversion scale (set with command C102), and the calibration (set with command C103). When you want to read the analog lines as part of a custom message such as "The temperature is ??? degrees fahrenheit" you should use the read-analog-input special words (see words numbered 500 and higher in Appendix B). They will allow you to read the input without all of the extra "I/O ? Line ?" words that you won't want in your messages.

Description	Command	Response
Read Analog	C100*X Y	See Below
Read Analogs	C100*X Y..Y	See Below

Format:
- C100 is the default command name.
- X is the I/O board number (1..2)
- Y is the analog input line number (1..8)
     Note: Multiple input lines can be read with one call to this command by entering more than one port number here.

Command Description: C101
Set Resolution For Analog Input

This command allows you to specify how many digits after the decimal point will be used when reading each analog input line. If you want to read voltage to 1/10 of a volt, you specify one digit after the decimal point. This decimal point is assumed in the other analog commands since there is no good way to enter a decimal point on a DTMF pad. If you specify one decimal place with this command, the other analog commands will assume that the numbers you enter have an assumed decimal point one digit from the end. In other words, if you want to specify a value of 12 volts and you are using one digit after the decimal point, you must enter 120. The descriptions of those commands will explain this in more detail.

Description	Command	Response
Set Precision	C101*X Y Z	See Below

Format:
    - C101 is the default command name.
    - X is the I/O board number (1..2)
    - Y is the analog input line number (1..8)
    - Z is the number of digits after the decimal point (0..3)

If you don't care what happens if you exceed the resolution of the converter, skip all of the following information and ignore this command. Please note that although you can specify as many as 3 decimal places, that doesn't mean that the analog to digital converter has that much resolution. It accepts a voltage between 0 and 5 volts (at the processor, voltage dividers on the I/O board and external to the RLC-3 can both affect the maximum voltage that can be handled) and can differentiate 1024 levels within that range, about 5mV per level. LM335 temperature sensors output a voltage of 10mV per degree Kelvin (celsius - 273). This corresponds to about 5mV (10mV * 5/9) per degree fahrenheit. If a temperature sensor is hooked up with no voltage divider (the recommended way since it outputs less than 5 volts), this gives approximately one degree resolution (it is actually slightly better than a degree). There is no reason to try to read temperature with two decimal places when the actual resolution of the conversion is only to the even degree (0 decimal places), it would just add meaningless digits. Even one digit after the decimal point is pushing it - it would sound like you were getting 1/10 degree resolution even though you would really only be getting about 1/2 degree resolution. We recommend reading temperature to the nearest degree (0 digits after the decimal point).

Another example: reading battery voltage. Since your battery probably supplies between 12 and 14 volts, it can be read with the voltage divider on the I/O board switched on to provide a range of 0..25 volts. This is 5 times the range (25/5=5) that is presented to that processor, so your precision is reduced to 1/5 of what it was (from 5mV to 25mV). You can therefore read your battery voltage with one digit after the decimal point (100mV resolution) and waste a

little resolution, or use two digits after the decimal point (10mV) and exceed the resolution of the converter.

Let us suppose that we are trying to read the voltage supplied by a 3 volt battery pack with 3 digits after the decimal point (1mV resolution). Remember that the converter has only 5mV resolution (let us suppose it is exactly 5mV for this example). If the battery voltage is 3.002 volts, the converter will round it to 3.000. If the voltage is 3.003 volts, the converter will round it to 3.005. No matter what you do, the last digit read will always be 0 or 5. The number read back by the controller will sound like it has 1mV resolution, but the reading will only have 5mV resolution.

If all of this has confused you, ignore it and select 0 digits after the decimal point (or leave it alone if you haven't changed it - 0 digits is the default).

Command Description: C102
Set Conversion Ratio For Analog Input

This command allows you to select what scale the analog inputs are read on. This allows you to use the analog inputs to read temperature on a scale from hundreds of degrees below zero to hundreds above, battery voltage on a scale from 0 to 25 volts or wind direction from 0 to 360 degrees. Anything that can generate an analog voltage can be read on a scale appropriate to the measurement. Unfortunately, this flexibility brings with it a little complexity. To make it easy, we provide a chart of the common conversions you might use. If you want to use a conversion that is not listed, read the explanations after the chart and study the examples on the chart. Once you see the pattern, the calculations are not difficult.

Please note that regardless of the conversion used, the voltage entering the I/0 board must be between 0 and 5 volts when the voltage divider is not used, and 0 and 25 volts when it is used.

```
   Description    |        Command        |     Resolution

 General Form     | C102*X Y N WWWW M ZZZZ |
 Temperature      | C102*X Y 1 0460 0 0440 | 1 degree F (0)
 Temperature      | C102*X Y 1 0273 0 0227 | 1 degree C (0)
 0 to 5 volts     | C102*X Y 0 0000 0 0005 | 1 volt     (0)
 0 to 5 volts     | C102*X Y 0 0000 0 0050 | 1/10 volt  (1)
 0 to 5 volts     | C102*X Y 0 0000 0 0500 | 1/100 volt (2)
 0 to 25 volts    | C102*X Y 0 0000 0 0025 | 1 volt     (0)
 0 to 25 volts    | C102*X Y 0 0000 0 0250 | 1/10 volt  (1)
 0 to 25 volts    | C102*X Y 0 0000 0 2500 | 1/100 volt (2)
 0 to 100 %       | C102*X Y 0 0000 0 0100 | 1 percent  (0)
 0 to 360 deg     | C102*X Y 0 0000 0 0360 | 1 degree   (0)
```

Notes:
     The numbers in parenthesis in the resolution column indicate the number of digits after the decimal point (see command C101).
     For a more information about hooking up a LM335Z temperature sensor, see Appendix I.

Format:
     - C102 is the default command name.
     - X is the I/O board number (1..2)
     - Y is the analog input line number (1..8)
     - N is 1 for negative, 0 for positive for the following number
     - WWWW is the reading with a 0 volt input with leading 0s if necessary
     - M is 1 for negative, 0 for positive for the following number
     - ZZZZ is the reading with a 5 volt input to the processor with leading 0s if necessary. If the voltage divider on the I/O board is turned on, this is the reading with a 25 volt input.

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If the conversions provided in the chart are what you need, don't bother reading this section. It describes how to come up with your own conversions.

The conversion is simply a linear ratio. You provide a reading that corresponds with 0 volts at the processor and another number that corresponds with 5 volts at the processor, and the controller just does a linear interpolation.

First we will describe some of the conversions in the table, then illustrate how to come up with your own:

0 to 5 volt, 1 volt resolution, no voltage dividers:
    This is about as straightforward as it can get. When it reads 0, it converts it to zero. When the processor reads 5 volts, it converts it to 5 volts.

0 to 5 volt, 1/10 volt resolution, no voltage dividers:
    When it reads 0, it converts it to zero. To get 1/10 volt resolution, we need to use one digit after the decimal point. Because of this we have to assume one decimal point when we enter the conversion points. When the processor reads 5 volts, we need to to convert to 50, which with one assumed decimal place, is 5.0 volts.

0 to 5 volt, 1/100 volt resolution, no voltage dividers:
    When it reads 0, it converts it to zero. To get 1/100 volt resolution, we need to use two digits after the decimal point. When the processor reads 5 volts, we tell it to convert it to 500, which with one assumed decimal place, is 5.00 volts.

Temperature in Celsius, 1 degree resolution, no voltage dividers:
    The key to figuring this one out is knowing how the LM335 temperature sensor works. It provides an output voltage of 10mV per degree kelvin. It should therefore output zero volts at zero degrees kelvin. Zero degrees kelvin is minus 273 degrees celsius, so that is our first conversion point, -273. The 5 volt conversion point would be reached at 5V/10mV per degree = 500 degrees kelvin, or 227 degrees celsius (above zero). This is our other conversion point.

Temperature in Fahrenheit, 1 degree resolution, no voltage dividers:
    This conversion is very similar to the one for celsius temperature. 0 degrees kelvin is -460 degrees fahrenheit. 500 degrees kelvin is 440 degrees fahrenheit.

0 to 25 volt, 1 volt resolution, with the voltage divider:
    The difference between this and the 5 volt conversion is the voltage divider. The divider cuts the received voltage to 1/5 before passing it on to the processor. In other words, the zero point does not change, but the full-scale reading is now 25 rather than 5 volts. Since we want it to read 25 volts when we give it 25 volts, the zero point is 0 and the full scale point is 25. Seems too easy, doesn't it?

The other resolutions of the 0 to 25 volt conversions are left to a comparison with the 5 volt conversions.

One more example will illustrate how to develop a conversion that is not listed in the chart. Let us assume that we want to read the wind speed at our site and that we have an anemometer (wind speed detector) that reads 10 volts at 100 MPH. Since the maximum voltage is between 5 and 25 volts, it will work nicely with the voltage divider in the circuit. We will assume that 0 volts are produced when the wind is not blowing and that it increases linearly from there. That sets our zero point to be zero. We must calculate our full scale reading as if it will occur at 25 volts, even though the sensor will never put out that much voltage, because that is the 5 volt full scale reading at the processor times the 5:1 voltage divider ratio. What we need to know is how fast the wind would have to blow to give us a 25 volt signal. A simple ratio will give us the answer:

$$\frac{100 \text{ MPH}}{10 \text{ volts}} = \frac{X \text{ MPH}}{25 \text{ volts}}$$

    Cross Multiplying: 100 * 25 = 10 * X,   2500 = 10 * X,   X = 250 MPH

We now know that the low point is 0, the high point is 250, and that we need to use the voltage divider.

Command Description: C103
Calibrate an Analog Input

This command allows you to correct for small amounts of error in reading analog sources. It should not be used until the resolution and conversion ratios are set (with commands C101 and C102). It is not intended to fix readings that are way off (more that 20 percent or so). If you are getting a reading that is a long way off, go back to C102 and correct the conversion ratio. This command accepts as input the correct value for an analog input line and adds or subtracts the right amount from the reading it is receiving to make it equal what you say it is. To get rid of this correction factor, execute the reset calibration form of this command shown in the table below.

Note that the value you enter will have as many assumed decimal places as you set with command C101.

Description	Command	Response
Calibrate	C103*X Y N WWWW	
Reset Calib.	C103*X Y 2	

Format:
- C103 is the default command name.
- X is the I/O board number (1..2)
- Y is the analog input line number (1..8)
- N is 1 for negative, 0 for positive for the following number
- WWWW is the actual value that should be read by the sensor.

Advanced Command Description: C104
Set an Analog Alarm

This command allows you to set an alarm that will occur when an analog reading goes below a low alarm point or above a high alarm point. When the alarm occurs, it will execute an internal macro (see appendix D for internal macro definitions). You can program this internal macro to do anything, turn output lines on or off, speak a voice message, change your courtesy beep, etc. The alarm point will be checked at intervals determined by the length of the input alarm timer (see command C020). When the analog reading comes out of alarm by the "hysteresis" amount (set with command C105), the analog alarm clear macro will be executed. You might want to program this macro to change an output line and/or speak an alarm clear message.

Note that the value you enter will have as many assumed decimal places as you set with command C101.

Description	Command	Response
Set Alarm	C104*X Y L N WWWW	

Format:
- C104 is the default command name.
- X is the I/O board number (1..2)
- Y is the analog input line number (1..8)
- L is 0 for a low alarm, 1 for a high alarm
- N is 1 for negative, 0 for positive for the following number
- WWWW is the alarm point with leading 0s if necessary

Advanced Command Description: C105
Set Analog Alarm Hysteresis

Hysteresis is a concept not everyone is familiar with, so let me illustrate it before I try to explain how to use it. Let us suppose that you are using one of the analog lines to read the temperature inside of your radio shack. In the winter, you want the controller to automatically turn the heater on and off to keep the temperature above 40 degrees. To do this you decide to control the heater with a relay that you can switch with one of the output lines. Next you set a low alarm at 40 degrees and program the low alarm macro for that analog line to turn the heater on and speak the message "low alarm". Now you need a way to turn the heater back off. To do this you use the analog alarm to normal macro to turn the heater off and speak the message "low alarm clear". This is where hysteresis comes in. Do you want the heater to turn off at 41 degrees? This would probably make the heater turn on and off really often. It might be better if it warmed up to 45 degrees before the heater turned off, so it would turn on and off less often. The amount that it has to warm up past where the low alarm point was is the amount of hysteresis, in this case 5 degrees. In the case of a high alarm (such as would be used to run an air conditioner, the amount of hysteresis is how much the temperature would have to drop below the high alarm point before the alarm to normal macro would be executed. The amount of hysteresis is the same for the high and low alarms (if this is not acceptable for your application, let us know). This command lets you set how much hysteresis each analog line uses when determining whether the alarm is clear yet.

Note that the value you enter will always be positive and will have as many assumed decimal places as you set with command C101.

Description	Command	Response
Set Hysteresis	C105*X Y WWWW	

Format:
    - C105 is the default command name.
    - X is the I/O board number (1..2)
    - Y is the analog input line number (1..8)
    - WWWW is the alarm point with leading 0s if necessary

High Alarm Occurs

High Alarm Point

High Alarm is Cleared

High Alarm Point minus Hysteresis

Low Alarm is Cleared

Temperature

Low Alarm Point plus Hysteresis

Low Alarm Point

Low Alarm Occurs
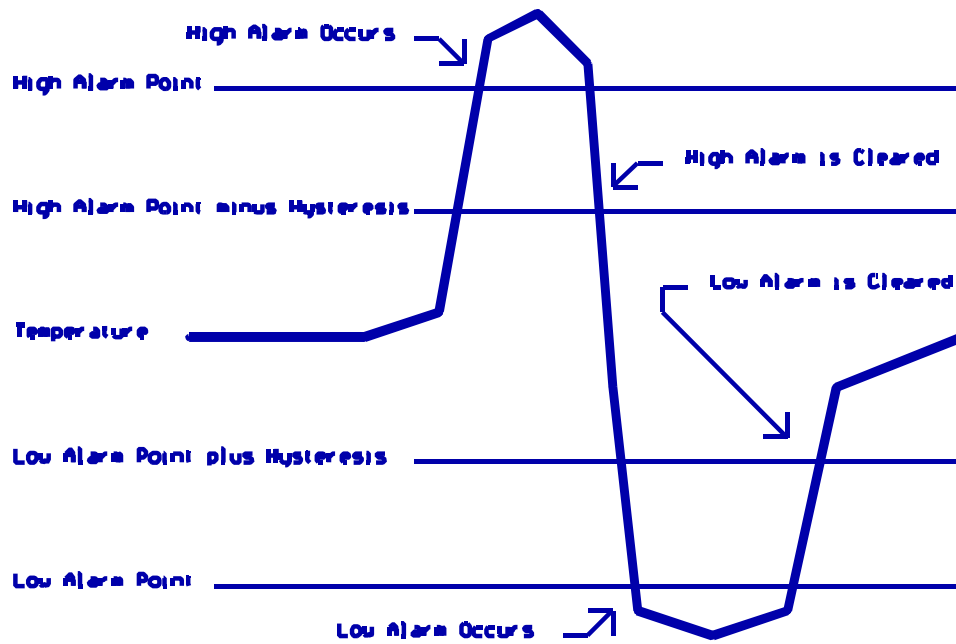
Advanced Command Description: C106
Enable/Disable an Analog Alarm

This command allows you control whether or not the analog alarms will occur without having to mess with the alarm points. This might be used to turn off a low temperature alarm while you are working at a site and have the door open or to disable turning a heater on when you are running on battery power. If an alarm is disabled, command C107 will still tell you whether or not the line is in alarm, but the alarm macro will never execute.

Description	Command	Response
Enable/Disable	C106*X Y L N	

Format:
- C106 is the default command name.
- X is the I/O board number (1..2)
- Y is the analog input line number (1..8)
- L is 0 for a low alarm, 1 for a high alarm
- N is 1 to enable the alarm, 0 to disable it

Advanced Command Description: C107
Recall Analog Lines in Alarm

This command lists all of the ports in high alarm, then all of the ports in low alarm. It is helpful when trying to find out whether you have set the alarm points correctly.

Description	Command	Response
Recall Alarms	C107*X	

Format:
  - C107 is the default command name.
  - X is the I/O board number (1..2)

Advanced Command Description: C108
Recall Analog Line Configuration

This command recalls all kinds of information about an analog line's conversion, resolution, calibration, alarm points, hysteresis, alarm enabled/disabled status, etc. It intended to aid in setting up the analog subsystem, not as a user command.

Description	Command	Response
Recall Config	C108*X Y	

Format:
- C108 is the default command name.
- X is the I/O board number (1..2)
- Y is the analog input line number (1..8)

Description of the voice response:
"I/O ?" - which I/O board we are referring to (1..2)
"analog ?" - which analog input on the I/O board we are referring to (1..8)
"0 volts is ?" - the lower calibration point
"5 volts is ?" - the upper calibration point
"calibrate ?" - how many units the calibration changes the reading
"low alarm ?" - the low alarm point
"high alarm ?" - the high alarm point
"h ?" - the amount of hysteresis
"low alarm ?" - whether alarm is on or off
"high alarm ?" - whether alarm is on or off

The Autopatch

Configuring the Autopatch:

Because any of the eight radio ports can be used as the autopatch port, you must tell the controller which radio port the autopatch is hooked up to. This is done with command C110. C110 also allows you to specify whether or not you want the autopatch to read back in the synthesized voice the number it is about to dial. If you select to have the number read back, you can choose whether it should read it back "politely" (so it can be interrupted by kerchunking) or "impolitely" (it always reads back the whole number).

Autopatch Up Commands:

There are three different commands that can be used to access the autopatch. All of them connect the port that the command was entered from to the autopatch port (as specified with command C110). Because of this, none of them can be executed from the serial port or by the scheduler (how do you connect an autopatch to a scheduler?). They are:

- Manual Off Hook. This command connects the radio port to the phone line without dialing any numbers. You can dial phone numbers without DTMF regeneration by executing this command, waiting for dial tone, and entering the number on your DTMF pad. Since the tones are not captured and regenerated but go out directly onto the phone line, there is no long distance checking, etc.

- Normal Forward Dial. This command is the one you would usually make available to users. Three digit numbers will access autodial slots, 4 through 11 digit numbers will be checked against the dialing tables (explained later), then regenerated over the phone line. If you have specified pre-dial digits (such as a '9' to get out of a local PBX) with command C115, they will be dialed first.

- Special Forward Dial. This command is similar to the normal forward dial but it bypasses the dialing table checks. It is the most convenient way to bypass all of the long distance checking. It will dial any predial digits that you have programmed with C115.

Hanging Up:

No matter which command was used to bring up the autopatch, command C114 will hang it up. If you want to have more than one hang up command, just make several different macros call C114.

Predial Digits:

Autopatches that are on a PBX often have to dial a '9' or some other combination of digits to reach the outside world. The RLC-3 has the ability to dial these digits for you. You can tell it what digits to dial and how long of delays to use before and after these "predial digits" with command C115. These digits will be dialed before every number that is dialed with the forward dial commands. You can chose whether or not they should be dialed before each autodial number. This allows you to dial numbers that do not require the predial digits by putting them in an autodial slot.

The Autodialer:

There are 1000 autodial slots that can each hold up to an eleven digit phone number. They are numbered 000 through 999. They can be accessed by executing either of the forward dial commands with the number of the autodial slot you want to dial. They can be programmed with command C124. You can find out what number is in an autodial slot with command C125. You can select whether or not the predial digits (set with command C115) get sent before the autodial number with command C126. This is useful for those using a PBX because it allows them to have some autodial slots go to internal numbers and some to dial the predial digits to get to the outside world. Command C127 allows you to enable or disable the use of an autodial slot. This allows you to keep an autodial number from being dialed without erasing the slot and having to re-program it later.

Limiting Call Length:

The time out timer for the autopatch port will time the total length of the call. If the timer expires, it will execute the autopatch port's time out macro (see appendix D) and hang the autopatch up. If you would like a message spoken when this happens, put the commands to speak that message in the time out macro. If you do not want the autopatch to time out, set the timer length to 0 with command C020. You will probably want to erase the contents of the the the time out clear macro with command C055.

You will be warned before the patch times out. Thirty seconds before timeout, three beeps will be sent out of the radio port and down the phone line (so both sides of the conversation know it). Two beeps are sent twenty seconds before, and one ten seconds before.

If you want to reset the patch time out timer, write a macro that calls command C022 and resets the time out timer for the autopatch port.

How the Dialing Tables Work:

There are three tables that all numbers dialed with the normal forward dial command will be checked against before they are dialed. These tables do not affect the other two autopatch up commands in any way. Having three tables may strike you as more complicated than it needs to be, but if you will stick with the explanation, you will see the flexibility it allows.

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Examples will illustrate typical setups, so if the descriptions confuse you, skip to the examples. All three of the tables are organized in "slots", so you can program slot 1 to block a certain type of number, slot 3 to block another, and so on. You should keep track of what you put in each slot as you program them, so that you can easily change them later. You can check the operation of the dialing tables at any time by either trying to dial a number with the forward dial command, or just *pretending* to dial it with command C123. This command will tell you whether a number would be blocked by the dialing table or would be dialed, without actually using the autopatch.

The Blocked-Prefixes Table:

If you do not program anything into any of the dialing tables, every number can be dialed. If you want to run an open autopatch, you will want a way to block long distance numbers to avoid getting billed for other peoples' calls. This used to be simple - if a number started with a '1' and was followed by 7 or 10 digits, it was long distance; otherwise it was not. In many areas, this is no longer true. The blocked-prefixes table allows you to block any prefix or area code. It does not look at the last four digits of the number - if you need to block a specific number (not a whole prefix or area code), see the blocked-numbers table.

Each length of number is dealt with separately. Blocking the prefix 123 (three digits plus the four digits that are ignored means you are dealing with seven digit numbers) will not block any eight digit numbers, even if they begin with 123. So the first thing we should do is block off all numbers that are a length that we never want to be dialed. The forward dial command will not execute with only one or two digits to dial, so we don't have to worry about those cases. Three digit numbers all call autodial slots, so we don't have to worry about them either. Since this table doesn't look at the last four digits of the numbers, it can't do anything about four digit numbers. If we want, we can block some or all of them with the nuisance-numbers table. So we are dealing with 5 to 11 digit numbers. Most people dial 7 digit (482-7515), 8 digit (1-482-7515), and 11 digit (1-406-482-7515) numbers, so we will block 5, 6, 9, and 10 digit numbers. We could block the 6 digit numbers 123456, 122548, 127342, and all other 6 digit numbers that start with 12 by programming slot 000 with the command C117*00012. Remember that this dialing table ignores the last four digits of the number, so we only need to specify 6-4=2 digits, in this case 12. We could now block all of the 6 digits starting with 13, 14, 21, 22... but this would be terribly inefficient. To make things easier, the '#' digit on your DTMF pad (or serial terminal keyboard) can be used as a "wildcard". It will match any decimal digit (0..9). Using '#' we can block all 6 digit numbers with one command: C117*000##. Repeating the process for 5, 6, 9 and 10 digits numbers, we enter:

    C117*000#   (block all 5 digit numbers with slot 000)
    C117*001##   (block all 6 digit numbers with slot 001)
    C117*002#####   (block all 9 digit numbers with slot 002)
    C117*003######   (block all 10 digit numbers with slot 003)

We will assume that all 7 digit numbers are local except for those starting with 999; we will block the 999 numbers and not put any of the rest of them in any of the tables so that they will get dialed without any special treatment.

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C117*004999   (block all 7 digit numbers starting with 999 with slot 004)

Eight digit numbers - now the fun starts. There are three prefixes other than your own (482 in the example) that you must dial a 1 then the number to access but are local (free) numbers. Let us call them 586, 587, and 994. It would be far too much work to block all of the other prefixes, only allowing those three to fall through, so we will block all eight digit numbers here, and make exceptions for those three prefixes in the allowed-prefixes table.

C117*005####   (block all 8 digit numbers with slot 005)

Eleven digit numbers are similar to 8 digit. We will assume that we want to block all 11 digit numbers except for those starting with 1-800, which we will deal with in the allowed-prefixes table.

C117*006#######   (block all 11 digit numbers with slot 006)

The Allowed-Prefixes Table:

The allowed-prefixes table works very similarly to the blocked-prefixes table. It overrides the settings of the blocked-prefixes table so that you can make exceptions to the groups of numbers that you blocked out there. We said that we wanted to allow eight digit numbers that start with 1-586, 1-587, and 1-994. We can do that as follows:

C119*0001586   (allow 8 digit numbers starting with 1586 with slot 000)
C119*0011587   (allow 8 digit numbers starting with 1587 with slot 001)
C119*0021994   (allow 8 digit numbers starting with 1994 with slot 002)

We also wanted to allow 11 digit numbers starting with 1-800 and any prefix, so we enter:

C119*0031800###   (allow 11 digit numbers starting with 1800 with slot 003)

While we are at it, let us allow all 8 or 11 digit numbers that start with 0, so that our users can make credit card or collect calls:

C119*0040###   (allow 8 digit numbers starting with 0 with slot 004)
C119*0050######   (allow 11 digit numbers starting with 0 with slot 005)

The Nuisance-Number Table:

This is the only table that will deal with the last four digits of a number. It is intended to stop harassing or unwanted phone calls. It over-rides both of the other tables. If you put a number in this table, it can not be dialed no matter what you put in the other two tables. If you don't want the club members pestering you while you are at work (phone number 482-7515), put your work number in the nuisance table like this:

C121*0004827515   (block the 7 digit number 482-7515 with slot 0)

This will keep people from dialing that specific number, even though they can still dial every other number in the 482 prefix. You can put your work number in an autodialer slot and have your spouse use that to reach you since the autodialer slots are not checked against any of these dialing tables - we assume that you check the numbers before you put them in an autodialer slot. If you don't publish which autodialer slot is your work number, you won't get any more annoying autopatch calls at work.

You can also use wildcards to block off ranges of numbers, although this is probably not useful since the last four digits tend to be relatively random. If you are finding yourself using wildcards in any digits except the last four, you probably need to re-think how you are setting up the other two tables - you should be blocking those numbers there. By "should" I mean that it would leave you more flexibility to work with later. If you block off a group of numbers in this table with a wildcard, you will not be able to make any exceptions with either of the other tables, since this one is the highest ranking.

If you want to block off all four digit numbers (as suggested earlier), you can do the following:

    C121*001####

Dialing Table Summary:

As you can see, the three-table structure provides a lot of flexibility in blocking and allowing calls. It is somewhat complex, but so is the phone system we are trying to deal with. A flowchart illustrating the dialing table checks that are gone through each time the normal forward dial command is executed follows on the next page.

Nuisance Number Table	Match Found →		Discard Number
↓ No Match			↑
Match Found ← Disallowed Prefix Table			
↓ No Match			
Allowed Prefix Table	Match Found →		
↓ No Match			
→ Dial the Number			
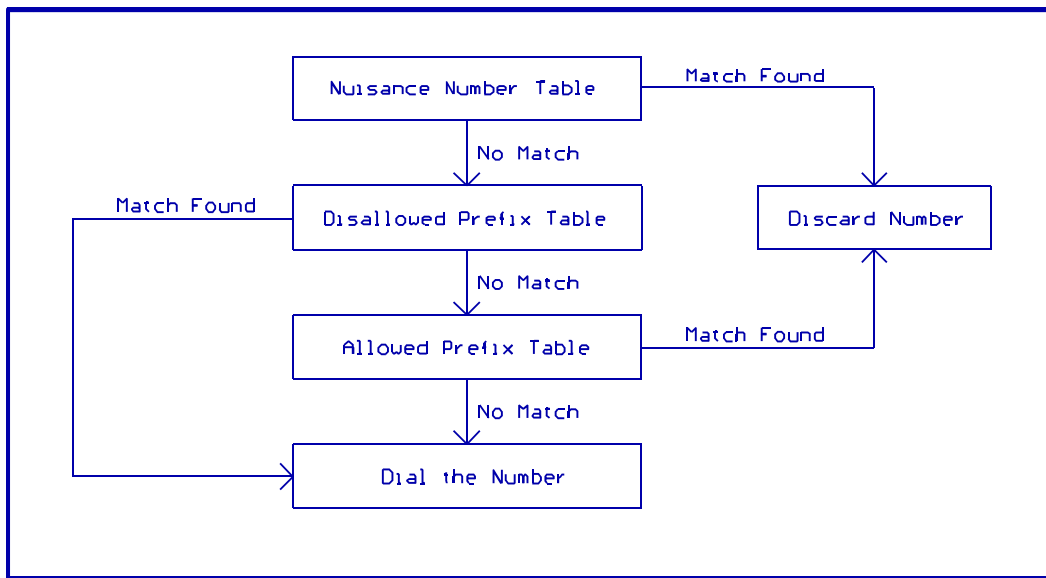
Command Description: C110
Configure the Autopatch

This command sets which port the autopatch interface is hooked to and allows you to choose whether and how the number is read back before it is dialed.

Description	Command	Response
Config Patch	C110*X Y	

Format:
- C110 is the default command name.
- X is the radio port that the autopatch is hooked to (1..8)
     Enter 9 to specify that no ports are autopatches
- Y is the readback style, described below:
     0 - do not read the numbers back before dialing them
     1 - read them back
     2 - read them back but stop and dial the number if the receiver is kerchunked
       Must be kerchunked before, during or shortly after number readback to dial.
     3 - read them back but stop and do not dial if the receiver is kerchunked
        Will dial if not kerchunked.

Notes:
- You can adjust messages and the length of the delays before and after the phone number is read back by editing macros 408..411, after you execute this command to set them up.
- If you change the autopatch port with this command, you will need to set up the reverse patch again with C133.

Advanced Command Description: C111
Manual Off Hook

This command connects the port from which the command is executed to the autopatch without dialing any numbers. Touch tones from your radio can be used to dial numbers without DTMF regeneration. Command C114 can be used to hang up the patch.

Description	Command	Response
Manual O.H.	C111*	

Format:
    - C111 is the default command name.

Command Description: C112
Normal Forward Dial

This is the normal autopatch up command you would make available to your users if you want an open autopatch. If the number you give it is 3 digits, it dials that autodial number. If it is longer, it checks it against the three dialing tables described before command C110 and if it passes, dials that number.. Command C114 can be used to hang up the patch.

Description	Command	Response
Autodial Slot Dial Number	C112*XXX C112*Y..Y	

Format:
  - C112 is the default command name.
  - XXX is the autodial slot number
  - Y..Y is the phone number you want to dial

Notes:

• If you want to get rid of the '*' between the command name and the phone number, look into command C080.

• There is currently no limit on the length of number that can be dialed, except for the maximum command length

• You can call this from a macro to dial numbers too long to fit in an autodial slot. For example: C053*50011201234567890123456789* will program macro 500 to bring up the patch and dial the number 01234567890123456789.

Advanced Command Description: C113
Forward Dial with no Long Distance Checking

This is the autopatch up command you would use if you wanted to dial a number without worrying about whether or not it is allowed by the dialing tables. You would not normally make this command available to the average user, because it would allow them to dial any number, including long distance, at your expense.

Description	Command	Response
Autodial Slot Dial Number	C113*XXX C113*Y..Y	

Format:
    - C113 is the default command name.
    - XXX is the autodial slot number
    - Y..Y is the phone number you want to dial

Note: if you want to get rid of the '*' between the command name and the phone number, look into command C080.

Command Description: C114
Hang up the Autopatch

This is the command to use to hang up the autopatch, no matter which of the three autopatch up commands you used to take it off-hook.

Description	Command	Response
Hang Up	C114*	

Format:
    - C114 is the default command name.

Advanced Command Description: C115
Set the Predial Digits and Timing

When either of the forward dial commands are used, several things must take place before the number is actually dialed:

- If number readback is turned on, speak the number.
- Take the phone line off-hook. This is the same as you picking up your phone at home.
- Since the controller can not listen to see if it gets dial tone from the phone line, it just delays for a little bit and assumes that dial tone is there. We will call this delay the "initial delay".
- If you must dial '9' or some other digits to get out of a local switchboard or PBX, those digits should be dialed here. We will call those "predial digits". You can also use these predial digits to dial special codes to turn on or off call waiting, caller ID, and other special features that your phone company may offer. They can be omitted if you are are not on a PBX.
- After dialing the predial digits, you may need to delay again while the PBX hooks you up to an outside telephone line. We will call this delay the "after-predial delay". This delay can be set to zero if you are not using predial digits.
- Now we can dial the actual number.

This command lets you set the initial delay, predial digits (if any), and after-predial delay.

Description	Command	Response
Setup Predial	C115*III AAA D..D	

Format:
- C115 is the default command name.
- III is the length of the initial delay in 10mS increments (000..250)
- AAA the length of the after-predial delay in 10mS increments (000..250)
- D..D are the predial digits. They can be omitted. The maximum number of predial digits is 10. Any of the 16 DTMF digits can be used.

Defaults:
Initial delay = 100 (1 second)
After-predial delay = 100 (1 second)
Predial digits = none

Advanced Command Description: C116
Recall the Predial Digits and Timing

This command allows you to recall the settings that were programmed with C115.

Description	Command	Response
Recall Predial	C116*	

Format:
   - C116 is the default command name.

Advanced Command Description: C117
Set Blocked Prefix Slot

This command allows you to set one of the slots in the blocked prefix table. For a description of this table and how to use it, see the autopatch section before command C110.

Description	Command	Response
Set Blocked	C117*SSS N..N	

Format:
    - C117 is the default command name.
    - SSS is the slot number (000..149)
    - N..N is the area code/prefix (do not include the last four digits of the phone number). The '#' digit is a wildcard that matches any digit.

Advanced Command Description: C118
Recall Blocked Prefix Slot

This command allows you to recall the contents of one of the slots in the blocked prefix table. For a description of this table and how to use it, see the autopatch section before command C110.

Description	Command	Response
Recall Blocked	C118*SSS	

Format:
- C118 is the default command name.
- SSS is the slot number (000..149)

Advanced Command Description: C119
Set Allowed Prefix Slot

This command allows you to set one of the slots in the allowed prefix table. For a description of this table and how to use it, see the autopatch section before command C110.

Description	Command	Response
Set Allowed	C119*SSS N..N	

Format:
    - C119 is the default command name.
    - SSS is the slot number (000..149)
    - N..N is the area code/prefix (do not include the last four digits of the phone number). The '#' digit is a wildcard that matches any digit.

Advanced Command Description: C120
Recall Allowed Prefix Slot

This command allows you to recall the contents of one of the slots in the allowed prefix table. For a description of this table and how to use it, see the autopatch section before command C110.

Description	Command	Response
Recall Allowed	C120*SSS	

Format:
- C120 is the default command name.
- SSS is the slot number (000..149)

Advanced Command Description: C121
Set Nuisance Number Slot

This command allows you to set one of the slots in the allowed prefix table. For a description of this table and how to use it, see the autopatch section before command C110.

Description	Command	Response
Set Nuisance	C121*SSS N..N	

Format:
- C121 is the default command name.
- SSS is the slot number (000..149)
- N..N is the whole number to be blocked (do include the last four digits of the phone number). The '#' digit is a wildcard that matches any digit.

Advanced Command Description: C122
Recall Nuisance Number Slot

This command allows you to recall the contents of one of the slots in the nuisance number table. For a description of this table and how to use it, see the autopatch section before command C110.

Description	Command	Response
Recall Nuisanc	C122*SSS	

Format:
    - C122 is the default command name.
    - SSS is the slot number (000..149)

Advanced Command Description: C123
Test Dialing Tables

This command allows you to test the dialing tables. It takes the telephone number you enter and tests it in the exact same way the normal forward dial command does, but instead of dialing the number, it just tells you whether or not the number is rejected by the dialing tables. This comes in very handy when setting up the dialing tables, because you don't have to actually dial and hang up numbers to see if they are blocked or not. This command also works from the serial port, allowing you to check the dialing table from a terminal or computer.

Description	Command	Response
Test Tables	C123*N..N	

Format:
    - C123 is the default command name.
    - N..N is the number you wish to test with the dialing tables

Command Description: C124
Set Autodial Slot

This command allows you to set one of the autodial slots. For a description of the autodial slots and how to use them, see the autopatch section before command C110.

Description	Command	Response
Set Autodial	C124*SSS N..N	

Notes:

- You will probably want to program autodial slot 911 to dial 911 or whatever your local emergency number is.

- You can clear the data out of a slot by entering C124*SSS*

- You can disable a slot without erasing it with command C127.

Format:
　　- C124 is the default command name.
　　- SSS is the slot number (000..999)
　　- N..N is the whole number to be dialed (up to 11 digits), but not including any predial
　　　　digits (they must be set with C115 - you can keep them from being sent for an autodial
　　　　slot with C126).

Command Description: C125
Recall Autodial Slot

This command allows you to recall the contents of one of the autodial slots.

Description	Command	Response
Recall Autodial	C125*SSS	

Format:
- C125 is the default command name.
- SSS is the slot number (000..149)

Advanced Command Description: C126
Set Whether to Send Predial Digits for Autodial Slot

You can ignore this command if you are not using any predial digits. This command allows you to control whether or not the predial digits will be sent before an autodial number. The default is to send them. By telling the controller not to send them, you can dial extensions on the PBX you are on (numbers that don't need the predial digits) with an autodial slot. The initial delay and after-predial delay (see command C115) are sent in either case.

Description	Command	Response
Send Predial?	C126*SSS X	

Format:
- C126 is the default command name.
- SSS is the slot number (000..999)
- X is 1 to send the predial digits, 0 to not send them.

Advanced Command Description: C127
Enable/Disable an Autodial Slot

This command allows you to disable an autodial slot without erasing its contents so you can enable it later without having to re-enter the number.

Description	Command	Response
En/Disable Slt	C127*SSS X	

Format:
    - C127 is the default command name.
    - SSS is the slot number (000..999)
    - X is 1 to enable the slot, 0 to disable it

Command Description: C128, C129
Set and Recall Half-Duplex Mode for a Selected Port

These commands allow you to program and recall whether the specified port will be treated as a half or full duplex port. The default is full duplex. Currently the setting is only used for the autopatch. In full-duplex mode, audio from the phone is sent regardless of whether the port that is using the patch is keyed or not. In half-duplex mode, the phone audio is muted whenever the radio port is keyed. This setting may also be used for other things later.

Description	Command	Response
Set Half-Duplex	C128* X Y	ON/OFF
Recall	C129*	All Half-Dup Ports

Parameters:
- C128 is the default command name.
- X is the requested port (1..8)
- Y is the Half-Duplex on/off setting
    -- 1 ==> make the selected port half duplex
    -- 0 ==> make the selected port full duplex

Default:
- full duplex

The recall command lists all of the ports that are in half-duplex mode. If the port number is not listed, it is in full-duplex mode.

Blocking Execution from Certain Ports

Purpose of these commands:

The following three commands allow you to mark certain commands so that they can not be executed from certain ports. You might want to use this command to make it so your autopatch can not be accessed from the link ports. If you are using one of the ports as a control port, you could make all of the commands in the controller so they could only be executed from that control port. You could call these commands from the scheduler to disable some or all of the commands at night. This adds a lot of security to your controller.

Caution:

Because these commands can keep you from executing commands, they can lock you out of your own controller. If you have a terminal or computer hooked up to the serial port, these commands can not lock you out, so you don't have to worry about it. Also, you can always re-initialize the controller (see Appendix E), but that erases all of your programming and you have to be at the site to do it. In other words, be careful what commands you block and what ports you block their execution from. If you don't want to use these functions and you want to erase their names so that they can not be entered accidently, enter the following commands:

    C010*130*
    C010*131*
    C010*132*

These commands erase the names of command numbers 130, 131 and 132 so that they can not be executed without renaming them to a valid name.

If you think you have locked yourself out, execute the following sequence of commands from every port you can get touch tones to, or just from the serial port (where it will always work). If they are executed they will allow access to every command from every port.

    C132*1000999*
    C132*2000999*
    C132*3000999*
    C132*4000999*
    C132*5000999*
    C132*6000999*
    C132*7000999*
    C132*8000999*

Advanced Command Description: C130
Block Command Execution From Port

This command allows you to block execution of a command or a range of commands by a port. Before using it, please read the cautions on the previous page.

Description	Command	Notes
Block Execution	C130*P CCC	Single Command
Block Execution	C130*P CCC DDD	Range Of Commands

Format:
- C130 is the default command name.
- P is the port to block access by
- CCC is the first command number to block
- DDD is the last command number in the range of commands to block

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Advanced Command Description: C131
Allow Command Execution From Port

This command allows you to reverse the effects of C130 and allow the specified port to execute a command or range of commands again. This command is not dangerous - it can not lock you out of your own controller.

Description	Command	Notes
Allow Execution	C131*P CCC	Single Command
Allow Execution	C131*P CCC DDD	Range Of Commands

Format:
- C131 is the default command name.
- P is the port to allow access by
- CCC is the first command number to block
- DDD is the last command number in the range of commands to block

Advanced Command Description: C132
Recall Blocked Ports

This command allows you to recall which ports are blocked from executing a command.

Description	Command	Notes
Recall Blocked	C132*CCC	

Format:
   - C132 is the default command name.
   - CCC is the first command number to block

Advanced Command Description: C133
Set up Reverse Patch

This command allows you to set up the reverse patch functions to work the way you want them to. You must set up the forward patch functions with C110 before you use this command. If you want to change how the reverse patch works, just execute this command again with the new information.

Description	Command	Response
Disable Rev Pat Ring Over Air Control Mode	C133*0 C133*1 XX Y..Y C133*2 XX N..N	Will Repeat the numbers you enter

Format:
- C133 is the default command name.
- There are three reverse patch "modes".
    - Mode 0 disables the reverse patch. Forward patch will still work normally.
    - Mode 1 is the ring over air mode. After XX rings, the reverse patch will begin sending a ring indication (set with C136) out radio ports Y..Y every time the phone rings. Any radio port can answer the call with command C135.
    - Mode 2 is the control mode. After XX rings, the controller will answer the phone and give you about 9 seconds to enter the access code N..N then the EOF digit (usually a '*', see command C078), or it will hang up on you. If you enter the code N..N and a '*', it will speak "Control" and let you enter commands by DTMF just as you would from a radio port. Since you can't unkey to tell the controller to execute the command, you will have to press '*' after each command to make it execute. If you mess up entering the access code, just press '*' and try again. Note that since telephones don't have the DTMF digits 'A', 'B', 'C', or 'D', you will not be able to use these digits in the access code, which can be 1 to 6 digits long. You will also have to rename any commands you wish to execute from the telephone to not contain these digits.

    After executing command C134, you can go out over radio ports or just monitor them by executing commands C000 and C001 (of course you must rename them to get rid of the 'C'). For example, if your autopatch is on port 8 and you wish to monitor the repeater on port 1, execute command C001*81*. This will make the autopatch (port 8) monitor the repeater (port 1).

Advanced Command Description: C134
Access Reverse Patch Control Mode

You do not need to know about this command - it is for the controller's internal use when using reverse patch mode 2 (control mode), so you can quit reading now if you want. When the controller answers the phone in mode 2, the only commands you can execute are the preaccess macros for the autopatch port, because the controller turns preaccess on when you set up the patch. When you specify the reverse patch access code with C133, it renames one of the preaccess macros for that port to the access code and programs that macro to call this command when executed. This command allows you to access all of the commands until the patch is hung up, resets the patch time out timer, and stops the preaccess timer, among other things. If you are controller in reverse patch mode 2 and the time out timer is about to expire, you can execute this command to keep the patch from timing out.

Description	Command	Response
Control Mode	C134*	"Control"

Format:
 - C134 is the default command name.

Advanced Command Description: C135
Answer Reverse Patch

This command is used to answer a reverse patch call that is ringing out over the air (reverse patch mode 1 - see command C133). It will only work when the reverse patch is ringing - it is not a substitute for the manual off-hook command. The patch is hung up the same way as for forward patch, with command C114.

Description	Command	Response
Answer Rev Pat	C135	

Format:
    - C135 is the default command name.

Command Description: C136
Set up Reverse Autopatch Ring

This command allows the user to set up the over the air ringing tone and length.

Description	Command	Response
Ring Set-up	C126*XXX YYYY ZZZZ	See Below

Parameters:
- C126 is the default command name.
- XXX is the length of the ring tone
    - Defaults to 1 Second
- YYYY is the Frequency of the first ring tone
    - Defaults to 0660 Hz.
- ZZZZ (optional) is the Frequency of the second ring tone
    - Defaults to 1000 Hz.

Suggestions:
    Do not make the length of the ring tone too long. The controller will stack up tone requests and could still be ringing over the air after the phone has answered if the length of the tone is longer than the delay between rings from your phone company.

Command Description: C137
Autodial Only

This is the same as the other dialing commands except it will only let you dial autodial numbers.

Description	Command	Response
Autodial Slot	C137*XXX	

Format:
- C137 is the default command name.
- XXX is the autodial slot number

Advanced Command Description: C138
Direct SPI Send out of Radio Card's Serial Port

This command is provided only for advanced use controlling SPI devices. Unless you need to control a serial shift register or perform a direct transfer to the Doug Hall RBI-1, ignore this command.

Description	Command	Response
SPI Send	C138*P XXX XXX ... XXX	

Format:
- C138 is the default command name.
- P is the radio card to send the SPI data out of
- XXX is a decimal number 000..255 representing a byte of data to send

Doug Hall's RBI-1 Support

What it is:

Doug Hall Electronics' Remote Base Interface (RBI-1) allows the RLC-3 to control the Kenwood series TM-X21 and TM-X31 mobile radios. The RBI-1 converts the data output by the RLC-3 into a format that the radios can use. Up to four bands can be supported by one RBI-1 interface, which plugs into one of the RLC-3's radio cards. The audio, COR and PTT interface is made through the RLC-3 card's radio port (the bottom DB-9) and the signals that control the RBI-1 and ultimately the radio come from the serial port on the radio card (the top DB-9 connector). More information about the RBI-1, including the address and phone number for Doug Hall Electronics, is included on the following pages. Link Communications does not sell the RBI-1 interface.

Interfacing and Setup:

It is very easy to interface the RBI-1 to the RLC-3. A schematic of the needed cable is provided on one of the following pages. You can build it yourself or order one from Link Communications. The radio is connected to the RBI-1's microphone connector with a cable supplied with the RBI-1. The only other connections are power, ground and antenna to the radio. The RBI-1 gets its power from the radio.

Configuring the RLC-3 to control the RBI-1 consists of executing two commands. The first will tell the RLC-3 what radio card inside the RLC-3 the RBI-1 is connected to (command C140). After that, all of the commands that control the RBI-1 (C140..C150) will automatically be directed to the correct radio card. The second tells the RLC-3 which band unit you want to use (command C041).

Using the RBI-1:

Using the RBI-1 is very straightforward. There are separate commands to do each of the following tasks:
• C141 - select the band unit
• C142 - set the frequency (and optionally the offset)
• C143 - set the offset
• C144 - set the format used to set the offset
• C145 - set the power level
• C146 - set the PL (CTCSS) frequency
• C147 - turn the PL encoder on or off
• C148 - turn the PL decoder on or off
• C149 - recall the frequency and offset
• C150 - recall all of the current settings
If there are combinations of settings that you use often, you may want to program user macros to select those settings. This is the easiest way to get "memories" or "presets".

DHE
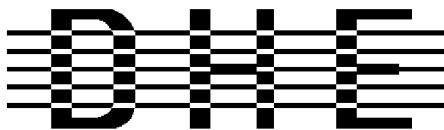
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FAX 261-8805

INTRODUCTION

The DHE Remote Base Interface (RBI-1) Adapts the Kenwood series TM-X21 and TM-X31 mobile radios to several brands of Repeater Controllers. The RBI model 1 converts the serial data stream from the Controller and Directly controls the Kenwood Mobile radio. All connections to the Kenwood radio are made thru the microphone jack. In the maximum configuration using a Kenwood TM-701 Dual Band Mobile you can control Frequency, CTCSS encode On/Off, RF power level, Offset, Power On/Off, and Band. This is all accomplished thru the microphone jack.

The RLC-3 Format supports the following functions:
• Full frequency control, 4 ports/radios, and 4 bands.
• Transmitter power HI/MED/LOW
• CTCSS Frequency select, Encode on/off, Decode on/off.
    -20 and -12 Mhz offsets on 1200.

The Supported Kenwood Mobile Radios are as follows:

140	220	440	1200	Dual Band	
TM-221	TM-321	TM-421	TM-521	TM-621+	TM-721+
TM-231	TM-331	TM-431	TM-531	TM-631+	TM-731+
TM-241		TM-441	TM-541		TM-701+

+ Dual Banders

SUPPORT CROSS REFERENCE

FUNCTION	CTCSS ENCODE	CTCSS SELECT	CTCSS DECODE	MULTI BAND	RF PWR POWER
GENERIC	Y	Y	Y	Y	Y
TM-X21	Y	N	N		N
TM-X31	Y	Y	Y		Y
TM-X41	Y	Y	Y		Y
TM-621/721	Y	N	N	Y	N
TM-631/731	Y	N	N	Y	N
TM-701	Y	Y	Y	Y	Y

SPECIFICATIONS

Microprocessor: INTEL 87C51 Series 12MHz

Connections:
        Power: RCA Phono + center pin.
        Controller: 9 Pin female "D" Connector
        Expansion: 9 Pin male "D" connector.
        Radios: 4 8 Pin Modular Compatible with Kenwood PG-4H cable.
                           1 PG-4H provided. Additional cables available from Kenwood or DHE.

Adjustments: "T" (VR1) Radio transmit audio level adjust.
                           "R" (VR2) Radio receive audio level adjust.

Audio: Radio Transmit 0.050V to 2.5V Input. (response controlled by capacitor
                           removal)
                           Impedance 15K.
                           Radio Receive 0.020V to 2.5V Output. (response controlled by capacitor
                           removal)
                           Impedance 5K.

"S" Meter output: 0 to +5V 0V = no signal, 5V = > "S" 9.
                           Output impedance approx 5K.

Expansion output: 8 outputs, ground active, Sink 500mA each, 1A maximum total.

Power Requirements: +10 to +14 Vdc @ 23mA.

Size: 1.5" X 5.1" X 5.5"

INSTALLATION

Place or mount the RBI-1 in close proximity to the Kenwood mobile radio to be used. Connect the RBI-1 with the provided PG-4H Cable from the 8 pin modular jack marked "RADIO" to the Kenwood Microphone jack. Only Port 1 (140/DUAL) will support a Dual Band radio. Port 1 is the only Port the 140 Mhz radio can be connected to.

The RBI will support all 4 bands (140/220/440/1200) as follows:
If Port one is filled, Port 2 is for 220 only, Port 3 is for 440 only, Port 4 is for 1200 only. Basically, if the selected band is unavailable on Port 1 it will go to the port hard assigned to that band.

RBI-1 Connector J2	RLC-3 Connections
Pin# - Line Name	Pin# - Line Name

_____

1 - RBI-1 RESET	(optional) connect to output on I/O board
2 - "S" Meter output	(optional) connect to analog input on I/O board
	Connections to serial port on the radio card (top DB-9)
3 - Data	2 - RLC-3 SPI data output
4 - Clock/Strobe	3 - RLC-3 SPI clock output
	Connections to the radio port (bottom DB-9)
5 - Kenwood TX Audio (T Pot)	4 - RLC-3 audio out
6 - Kenwood RX Audio (R Pot)	5 - RLC-3 audio in
7 - COS from Kenwood RX	7 - RLC-3 COR input (turn switch "CR" off - active high)
8 - PTT to Kenwood TX	3 - RLC-3 PTT output
9 - Ground	1 - RLC-3 ground connection

In case it wasn't clear, there is only one connector on the RBI-1 that goes to the RLC-3. It is connected to two different DB-9s on the RLC-3, both of which are on the same radio port card. The bottom connector provides the audio, COR and PTT connections. The top (serial port) connector porvides the control signals. This is not the main serial port the the RLC-3 motherboard. A schematic showing the above connections is on one of the following pages.

Audio receive level from the Kenwood to the Controller is controlled by VR2 (R). The audio level from the Controller to the Kenwood is adjusted by VR1 (T). Refer to your manuals for additional adjustments in your controller.

Capacitor C5 (10uF) Inside the RBI-1 Interface must be removed and replaced with a 1uF/25V Tantalum Capacitor for the Audio to sound correct.

RADIO SETUP

The Kenwood radios need certain parameters set up before they can be controlled from the RBI-1, such as STEP. Since the memory channels in the radio aren't used, you should reset the radio to make sure all of the settings are set to the factory defaults. Instructions about how to do this can be found in your Kenwood operating guide or in the list below.

TM-701	Hold the MR key down during power on to reset.
TM-X21	Hold the VFO/M and M.IN keys down during power on to reset.
TM-621/721	Hold the F key down during power on to reset.
TM-631/731	Hold the MR key down during power on to reset.
TM-X31	Hold the MR key down during power on to reset.
TM-X41	Hold the VFO key down during power on to reset.

Set the step size to 5KHz. (25Khz on 1200 Mhz units)
Set dual band radio's to single band.
Set power to desired setting. Remember, remote base transmitters can have a high duty cycle because it will be transmitting during all activity on the Repeater side. The mobile radio's used in a remote base configuration should be set to low power in most cases.
Set VFO/MEM to VFO for external frequency input.
Set CTCSS for desired frequencies. When using TM-X31/X41 series it will be set by the controller and will override your initial setting.
Set CTCSS Decode to off.
Set ABC and AL to off on models that support it.
Turn off Repeat functions.

Once these have been set, connect the Mike jack to the RBI. Reset the RBI to initialize the radio to the controller and get them in sync.

Any time there are manual changes from the radio front panel, the RBI and the Radio can get out of sync. This will require a RBI reset to correct. We recommend hooking the reset line from the RBI to an output from the controller. To reset the RBI-1, turn the output line on and back off. If you do not turn the line back off, the reset line will be held low, disabling the RBI-1. A macro can be used to let you toggle the output line with a single command.

Schematic For RBI-1 to RLC-3 Cable

The schematic has not been drawn up yet, so see the information on the previous pages. If you have been using the RBI-1 with an RLC-2, you do not need to change the radio interface and you can just change the three serial wires or make an adapter for the connector that went to the RLC-2's output port. The changes are shown below:

DB-9 Female	DB-9 Male
or wires that used to	To the RLC-3's
go to the RLC-2's	radio card's
output lines	serial port
pin 1	pin 5 (ground)
pin 2	pin 3 (clock)
pin 6	pin 2 (data)
pin 3	no connection (reset)

Also make sure that both jumper blocks on jumper J5 on the radio card that you connect the RBI-1 are on. There are four pins - the bottom two should be hooked together and the top two should be hooked together. This connects the processor's ouput lines to the serial port on the radio card.
Need Cable Schematic

Advanced Command Description: C139
Setup RLC-Icom Interface

The RLC-Icom interface allows the RLC-3 to control IC-900 band modules using the same commands as are used for the Doug Hall RBI-1. This command tells the controller which interface you are using (default is the RBI-1) and allows you to set up the RLC-Icom interface.

You must tell the RLC-3 which port the RLC-Icom is connected to with command C140 before using this command. If you do not, the setup commands will be lost and you will have to enter them again.

Once you have set up the RLC-Icom with this command, you can use all of the RBI-1 commands (commands 141..150) as described.

Description	Command	Response
Set for RBI-1	C139*000*	Set up DH
Setup RLC-Icom	C139*X SS*	Set up I X SS

Format:
- C139 is the default command name.
- *X* is the connector number on the RLC-ICM that the module you are setting up is plugged into (1..4).
- *SS* is the setup code described below

Procedure:
C   First tell the RLC-Icom which band module is plugged into each of its connectors. The setup codes are listed in the chart below. You will need to execute command C139 once for each setup code you wish to enter.

SS (the setup code)	Description
00	28 Mhz Module
05	50 Mhz Module
10	140..160 Mhz Module
15	220 Mhz Module
20	430..440 Mhz Module
25	1200 Mhz Module (not currently active)

The default setup for the RLC-Icom is to have connector 1 plugged into the 140..160 Mhz module, connector 2 plugged into the 220 Mhz module and connector 3 plugged into the 430..440 Mhz module. As an example, the following commands will enter those settings again:

    C139*110*
    C139*215*
    C139*320*

C   Second, you must tell each band module what size of offset to use when you select a plus or minus offset with commands C142 or C143. The setup codes follow:

SS (the setup code)	Description
30	100 Khz Offset
35	500 Khz Offset
40	600 Khz Offset
45	1 Mhz Offset
50	1.6 Mhz Offset
55	1.7 Mhz Offset
60	5 Mhz Offset
65	12 Mhz Offset
70	20 Mhz Offset

For example, to select a 100 Khz offset for the 140..160 Mhz module that is plugged into connector 1, enter C139*130*.

C   Setup codes 75, 80 and 85 are reserved for special offset memories, which are not yet supported.

C   You should normally use commands C000, C001 and C002 to control turning the remote
    base on and off and monitoring it. Those commands treat the whole RLC-Icom interface
    as one unit, connecting to and disconnecting from it the same way they would a link port.
    In addition to these commands, you can tell the RLC-Icom interface to enable transceive,
    enable receive only, or disable individual modules using the following codes:

SS (the setup code)	Description
85	Enable Transceive
90	Enable Receive Only (Transmit Disabled)
95	Disable Module Completely

For example, if you wanted to monitor the 140..160 Mhz module and the 220 module, but
only transmit on 220, you could enter C139*290* to disable transmitting on the 220
module on connector 2 and C139*185* to enable transceive on 140..160 Mhz (connector
1). If you then used C000 to connect the repeater port you were using to the port that the
RLC-Icom is on, you would be able to transmit on and receive from the 140..160 Mhz
module but only receive from the 220 Mhz module.

When you enter a new frequency, band, PL frequency, etc. with commands C142 to C148,
the module that is selected with C141 will automatically change to receive only mode
(like you used code 90 above).

You will probably want to write macros to enable transceive after changing frequencies.
The following commands will program macro 500 to enable transceive on the 140..160
Mhz module on connector 1 and name that macro to 12:

```
C053*500043*                    ; be silent for the rest of the macro
C056*500139185*                 ; enable transceive
C010*50012*                      ; rename macro 500 to 12
```

C   If you have properly entered the above commands, the RLC-Icom is set up and ready to
    use. To enter frequencies, turn PL on and off, etc., use the RBI-1 commands in this
    section of the manual (commands 141..150).

Advanced Command Description: C140
Set Port for RBI-1

This command allows you to tell the controller which port the Doug Hall RBI-1 is connected to. If this is not set or is set incorrectly, none of the other commands in this section (about the RBI-1) will work.

Description	Command	Response
Set RBI-1 Port	C140*P	DH on P

Format:
   - C140 is the default command name.
   - P is the port that the RBI-1 is connected to (1..8)

Advanced Command Description: C141
Set Band Unit for RBI-1

This command allows you to tell the Doug Hall RBI-1 which band unit you want to use. The valid band units are listed in the table below. Of course, you must have a radio that supports that band unit connected to the RBI-1 for this command to work.

Description	Command	Response
Set RBI-1 Band	C141*X..X	XXXX Megahertz

Format:
- C141 is the default command name.
- X..X is the band unit you want to select
     (enter only as many digits as shown below)

X..X	RBI-1 Band Selected	RLC-Icom Band Selected
20	Not Available	20MHz (10 meters)
50	Not Available	50MHz (6 meters)
140	140MHz (2 meters)	140MHz (2 meters)
150	Not Available	150MHz
160	Not Available	160MHz
220	220MHz	220MHz
430	430MHz	430MHz
440	440MHz	440MHz
1240	1240MHz	1240MHz
1250	1250MHz	1250MHz
1260	1260MHz	1260MHz
1270	1270MHz	1270MHz
1280	1280MHz	1280MHz
1290	1290MHz	1290MHz

Advanced Command Description: C142
Set Frequency (and optionally offset) for RBI-1

This command allows you change the frequency within the current band (set with C141) on the radio connected to the Doug Hall RBI-1. The frequency is always entered as four digits. The first digit represents the one MHz digit of the new frequency, the second digit the 100 KHz digit, etc. If a fifth digit is entered, it is used to specify the offset.

Description	Command	Response
Set RBI-1 Freq	C142*XXXX Y	see command C149

Format:
    - C142 is the default command name.
    - XXXX is the new frequency
    - Y (optional) is the new offset (see command C143 for the format)

Advanced Command Description: C143
Set Offset for RBI-1

This command allows you change the offset on the radio connected to the Doug Hall RBI-1. The offset is always specified as one digit, 0 to 3. There are two different common definitions of what digit corresponds with what offset. They are shown in the table below. The RLC-3 supports both. You can select which format you want to use with command C144.

Description	Command	Response
Set Offset	C143*X	

Format:
- C143 is the default command name.
- X is the new offset

X	Format 0	Format 1
0	Minus	Minus 20 (1200 band only)
1	Plus	Minus
2	Simplex	Simplex
3	Minus 20	Plus

Note:
    You can recall the current band unit, frequency, and offset with command C149.

Advanced Command Description: C144
Set Offset Format for RBI-1

This command allows you change the way you enter the offset with commands C142 and C143. The offset is always specified as one digit, 0 to 3. There are two different common definitions of what digit corresponds with what offset. They are shown in the table below. If you want format 0 (the default), you can ignore this command.

Description	Command	Response
Select Format 0	C144*0	
Select Format 1	C144*1	

Format:
    - C144 is the default command name.

    - X is the digit used to specify the offset with commands C142 and C143:

X	Format 0	Format 1
0	Minus	Minus 20 (1200 band only)
1	Plus	Minus
2	Simplex	Simplex
3	Minus 20	Plus

Defaults:
    - the default format is format 0.

Note:
    There is no command to recall which format you are using. If you are unsure, execute C143*1*. If it says "plus", you are using format 0. If it says "minus", you are using format 1.

Advanced Command Description: C145
Set Power Level for RBI-1

This command allows you change the power level of the radio connected to the Doug Hall RBI-1.

Description	Command	Response
Low Power	C145*0	Power Low
Medium Power	C145*1	Power Moderate
High Power	C145*2	Power High

Format:
    - C145 is the default command name.

Default:
    - the default is low power

Advanced Command Description: C146
Set PL Frequency for RBI-1

This command allows you change the PL (CTCSS) frequency of the radio connected to the Doug Hall RBI-1. The frequency you set will apply to both received and transmitted PL. See commands C147 and C148 to turn the PL encoder and decoder on and off.

Description	Command	Response
Set PL Freq	C146*X..X	The actual freq

Format:
- C146 is the default command name.
- X..X is the PL frequency in Hz. Valid frequencies are listed below. Default is 67.0 Hz.

Notes:
The RLC-3 makes selecting PL frequencies easy by allowing you to enter approximate values for the PL frequencies. For example, you can select a PL of 71.9 Hz by entering any of the following values for X..X in the command above: 71, 72, 710, 719, 7100, and 7190. The RLC-3 takes the number that you enter and finds the closest match among the valid PL frequencies. When the synthesized voice responds to this command, it tells you the actual frequency selected, even if the value you entered was approximate.

Valid RBI-1 PL Frequencies

67.0 Hz	85.4 Hz	103.5 Hz	127.3 Hz	156.7 Hz	192.8 Hz	241.8 Hz
71.9 Hz	88.5 Hz	107.2 Hz	131.8 Hz	162.2 Hz	203.5 Hz	250.3 Hz
74.4 Hz	91.5 Hz	110.9 Hz	136.5 Hz	167.9 Hz	210.7 Hz	
77.0 Hz	94.8 Hz	114.8 Hz	141.3 Hz	173.8 Hz	218.1 Hz	
79.7 Hz	97.4 Hz	118.8 Hz	146.2 Hz	179.9 Hz	225.7 Hz	
82.5 Hz	100.0 Hz	123.0 Hz	151.4 Hz	188.2 Hz	233.6 Hz	

Valid RLC-ICM PL Frequencies

33.0 Hz	54.9 Hz	82.5 Hz	114.8 Hz	159.8 Hz	189.9 Hz	233.6 Hz
35.4 Hz	56.8 Hz	85.4 Hz	118.8 Hz	162.2 Hz	192.8 Hz	241.8 Hz
36.6 Hz	58.8 Hz	88.5 Hz	123.0 Hz	165.5 Hz	196.6 Hz	250.3 Hz
37.9 Hz	63.0 Hz	91.5 Hz	127.3 Hz	167.9 Hz	199.5 Hz	254.1 Hz
39.6 Hz	67.0 Hz	94.8 Hz	131.8 Hz	171.3 Hz	203.5 Hz	
44.4 Hz	69.4 Hz	97.4 Hz	136.5 Hz	173.8 Hz	206.5 Hz	
47.5 Hz	71.9 Hz	100.0 Hz	141.3 Hz	177.3 Hz	210.7 Hz	
49.2 Hz	74.4 Hz	103.5 Hz	146.2 Hz	179.9 Hz	218.1 Hz	
51.2 Hz	77.0 Hz	107.2 Hz	151.4 Hz	183.5 Hz	225.7 Hz	
53.0 Hz	79.7 Hz	110.9 Hz	157.7 Hz	186.2 Hz	229.1 Hz	

Advanced Command Description: C147
Turn PL Encode Off/On for RBI-1

This command allows you turn the PL (CTCSS) encoder of the radio connected to the Doug Hall RBI-1 off or on.

Description	Command	Response
PL Encode Off	C147*0	
PL Encode On	C147*1	

Format:
- C147 is the default command name.

Default:
- the default PL encode off

Advanced Command Description: C148
Turn PL Decode Off/On for RBI-1

This command allows you turn the PL (CTCSS) decoder of the radio connected to the Doug Hall RBI-1 off or on.

Description	Command	Response
PL Decode Off PL Decode On	C148*0 C148*1	

Format:
   - C148 is the default command name.

Default:
   - the default PL decode off

Advanced Command Description: C149
Recall Band, Frequency and Offset for RBI-1

This command allows you recall the current band, frequency and offset settings of the radio connected to the Doug Hall RBI-1. The format of the voice response is given below. If you want information about power, PL, etc., see the next command: C050.

Description	Command	Response
Short Recall	C149*	See Below

Format:
 - C149 is the default command name.

Voice Response:
   XXX.YYY   The frequency in MHz. Determined by both the band (set with command C141) and the frequency within the band (set with command C142).
   O   The offset as indicated below:
          "minus"   minus offset
          "s" simplex
          "plus" plus offset
          "minus 20"   minus 20 MHz offset (1200 radios only)

Advanced Command Description: C150
Recall All RBI-1 Settings

This command allows you recall all of the current settings for the RBI-1. The format of the voice response is given below.

Description	Command	Response
Long Recall	C150*	See Below

Format:
   - C150 is the default command name.

Voice Response:
   "DH on X"   The RBI-1 is connected to port X (see command C140)
   XXX.YYY   The frequency in MHz. Determined by both the band (set with
                    command C141) and the frequency within the band (set with command
                    C142).
   O   The offset as indicated below:
                        "minus"   minus offset
                        "s" simplex
                        "plus" plus offset
                        "minus 20"   minus 20 MHz offset (1200 radios only)
   "power XXXX"   power setting is low/moderate/high"
   "PL XX.X Hertz"   PL (CTCSS) frequency is XX.X hertz
   "PL TX On/Off" PL encoder is on/off
   "PL RX On/Off" PL decoder is on/off

Advanced Command Description: C155
Enable or Disable PTT for a Port

This command allows you to turn a PTT off regardless of what else the controller is doing. It doesn't matter whether it is a repeater or a link, what receivers are active, or anything else, if this command gets executed with F=0, the PTT goes off and stays off. This command is not the best way to regularly shut off a repeater or link (use commands C000..C002 for that), but will get the job done in an emergency. The only way to make the PTT work normally is to execute this command with F=1 or to reintialize the controller.

Description	Command	Response
PTT Off	C155*PF*	See Below

Format:
- C155 is the default command name.
- P is which transmitter to turn off
- F is 1 to enable the PTT (the default) or 0 to disable it

Advanced Command Description: C156
Recall Which PTT are Enabled

This command allows you to recall which PTT are enabled and which have been turned off with C155.

Description	Command	Response
Recall PTT	C156*	See Below

Format:
   - C156 is the default command name.

Response:
   Ports that are set to operate normally are listed. Any ports not listed have their PTT disabled. Normal response: "1 2 3 4 5 6 7 8".

Command Description: C157
Event Macro Assign

This command allows the user to assign a macro or command call when an event occurs in order to get response or action to occur. These are useful for alarming, and interrogating events that occur.

Description	Command	Response
Event Table	C157*YYY ZZZ	See Below

Parameters:
    - C157 is the default command name
    - YYY is the Event Number (see table below)
    - ZZZ is the command number to call when an event occurs

Default:
    - All events are disabled
    - When an event is programmed, the event is enabled

Event Table:

000 - COR Active Port 1	044 - Port Inactive Port 5
001 - COR Active Port 2	045 - Port Inactive Port 6
002 - COR Active Port 3	046 - Port Inactive Port 7
003 - COR Active Port 4	047 - Port Inactive Port 8
004 - COR Active Port 5	048 - Any Connected RX Active 1
005 - COR Active Port 6	049 - Any Connected RX Active 2
006 - COR Active Port 7	050 - Any Connected RX Active 3
007 - COR Active Port 8	051 - Any Connected RX Active 4
008 - COR Inactive Port 1	052 - Any Connected RX Active 5
009 - COR Inactive Port 2	053 - Any Connected RX Active 6
010 - COR Inactive Port 3	054 - Any Connected RX Active 7
011 - COR Inactive Port 4	055 - Any Connected RX Active 8
012 - COR Inactive Port 5	056 - All Connected RX Inactive 1
013 - COR Inactive Port 6	057 - All Connected RX Inactive 2
014 - COR Inactive Port 7	058 - All Connected RX Inactive 3
015 - COR Inactive Port 8	059 - All Connected RX Inactive 4
016 - PL Active Port 1	060 - All Connected RX Inactive 5
017 - PL Active Port 2	061 - All Connected RX Inactive 6
018 - PL Active Port 3	062 - All Connected RX Inactive 7
019 - PL Active Port 4	063 - All Connected RX Inactive 8
020 - PL Active Port 5	064 - Any DTMF Active Port 1
021 - PL Active Port 6	065 - Any DTMF Active Port 2
022 - PL Active Port 7	066 - Any DTMF Active Port 3
023 - PL Active Port 8	067 - Any DTMF Active Port 4
024 - PL Inactive Port 1	068 - Any DTMF Active Port 5
025 - PL Inactive Port 2	069 - Any DTMF Active Port 6
026 - PL Inactive Port 3	070 - Any DTMF Active Port 7
027 - PL Inactive Port 4	071 - Any DTMF Active Port 8
028 - PL Inactive Port 5	072 - Any DTMF Inactive Port 1
029 - PL Inactive Port 6	073 - Any DTMF Inactive Port 2
030 - PL Inactive Port 7	074 - Any DTMF Inactive Port 3
031 - PL Inactive Port 8	075 - Any DTMF Inactive Port 4
032 - Port Active Port 1	076 - Any DTMF Inactive Port 5
033 - Port Active Port 2	077 - Any DTMF Inactive Port 6
034 - Port Active Port 3	078 - Any DTMF Inactive Port 7
035 - Port Active Port 4	079 - Any DTMF Inactive Port 8
036 - Port Active Port 5	080 - Port 1 DTMF Active 0
037 - Port Active Port 6	081 - Port 1 DTMF Active 1
038 - Port Active Port 7	082 - Port 1 DTMF Active 2
039 - Port Active Port 8	083 - Port 1 DTMF Active 3
040 - Port Inactive Port 1	084 - Port 1 DTMF Active 4
041 - Port Inactive Port 2	085 - Port 1 DTMF Active 5
042 - Port Inactive Port 3	086 - Port 1 DTMF Active 6
043 - Port Inactive Port 4	087 - Port 1 DTMF Active 7

088 - Port 1 DTMF Active 8
089 - Port 1 DTMF Active 9
090 - Port 1 DTMF Active A
091 - Port 1 DTMF Active B
092 - Port 1 DTMF Active C
093 - Port 1 DTMF Active D
094 - Port 1 DTMF Active *
095 - Port 1 DTMF Active #
096 - Port 2 DTMF Active 0
097 - Port 2 DTMF Active 1
098 - Port 2 DTMF Active 2
099 - Port 2 DTMF Active 3
100 - Port 2 DTMF Active 4
101 - Port 2 DTMF Active 5
102 - Port 2 DTMF Active 6
103 - Port 2 DTMF Active 7
104 - Port 2 DTMF Active 8
105 - Port 2 DTMF Active 9
106 - Port 2 DTMF Active A
107 - Port 2 DTMF Active B
108 - Port 2 DTMF Active C
109 - Port 2 DTMF Active D
110 - Port 2 DTMF Active *
111 - Port 2 DTMF Active #
112 - Port 3 DTMF Active 0
113 - Port 3 DTMF Active 1
114 - Port 3 DTMF Active 2
115 - Port 3 DTMF Active 3
116 - Port 3 DTMF Active 4
117 - Port 3 DTMF Active 5
118 - Port 3 DTMF Active 6
119 - Port 3 DTMF Active 7
120 - Port 3 DTMF Active 8
121 - Port 3 DTMF Active 9
122 - Port 3 DTMF Active A
123 - Port 3 DTMF Active B
124 - Port 3 DTMF Active C
125 - Port 3 DTMF Active D
126 - Port 3 DTMF Active *
127 - Port 3 DTMF Active #
128 - Port 4 DTMF Active 0
129 - Port 4 DTMF Active 1
130 - Port 4 DTMF Active 2
131 - Port 4 DTMF Active 3
132 - Port 4 DTMF Active 4
133 - Port 4 DTMF Active 5
134 - Port 4 DTMF Active 6

135 - Port 4 DTMF Active 7
136 - Port 4 DTMF Active 8
137 - Port 4 DTMF Active 9
138 - Port 4 DTMF Active A
139 - Port 4 DTMF Active B
140 - Port 4 DTMF Active C
141 - Port 4 DTMF Active D
142 - Port 4 DTMF Active *
143 - Port 4 DTMF Active #
144 - Port 5 DTMF Active 0
145 - Port 5 DTMF Active 1
146 - Port 5 DTMF Active 2
147 - Port 5 DTMF Active 3
148 - Port 5 DTMF Active 4
149 - Port 5 DTMF Active 5
150 - Port 5 DTMF Active 6
151 - Port 5 DTMF Active 7
152 - Port 5 DTMF Active 8
153 - Port 5 DTMF Active 9
154 - Port 5 DTMF Active A
155 - Port 5 DTMF Active B
156 - Port 5 DTMF Active C
157 - Port 5 DTMF Active D
158 - Port 5 DTMF Active *
159 - Port 5 DTMF Active #
160 - Port 6 DTMF Active 0
161 - Port 6 DTMF Active 1
162 - Port 6 DTMF Active 2
163 - Port 6 DTMF Active 3
164 - Port 6 DTMF Active 4
165 - Port 6 DTMF Active 5
166 - Port 6 DTMF Active 6
167 - Port 6 DTMF Active 7
168 - Port 6 DTMF Active 8
169 - Port 6 DTMF Active 9
170 - Port 6 DTMF Active A
171 - Port 6 DTMF Active B
172 - Port 6 DTMF Active C
173 - Port 6 DTMF Active D
174 - Port 6 DTMF Active *
175 - Port 6 DTMF Active #
176 - Port 7 DTMF Active 0
177 - Port 7 DTMF Active 1
178 - Port 7 DTMF Active 2
179 - Port 7 DTMF Active 3
180 - Port 7 DTMF Active 4
181 - Port 7 DTMF Active 5

182 - Port 7 DTMF Active 6
183 - Port 7 DTMF Active 7
184 - Port 7 DTMF Active 8
185 - Port 7 DTMF Active 9
186 - Port 7 DTMF Active A
187 - Port 7 DTMF Active B
188 - Port 7 DTMF Active C
189 - Port 7 DTMF Active D
190 - Port 7 DTMF Active *
191 - Port 7 DTMF Active #
192 - Port 8 DTMF Active 0
193 - Port 8 DTMF Active 1
194 - Port 8 DTMF Active 2
195 - Port 8 DTMF Active 3
196 - Port 8 DTMF Active 4
197 - Port 8 DTMF Active 5
198 - Port 8 DTMF Active 6
199 - Port 8 DTMF Active 7
200 - Port 8 DTMF Active 8
201 - Port 8 DTMF Active 9
202 - Port 8 DTMF Active A
203 - Port 8 DTMF Active B
204 - Port 8 DTMF Active C
205 - Port 8 DTMF Active D
206 - Port 8 DTMF Active *
207 - Port 8 DTMF Active #

Command Description: C158
Event Macro Recall

This command allows the recall of what macro or command an event will jump to when a change occurs.

Description	Command	Response
Event Table	C158*XX	See Below

Parameters:
    - C158 is the default command name
    - XX is the Event Number

Default:
    All events are disabled

Command Description: C159
Event Macro Enable/Disable

This command allows the enable/disable control of the automatic event calling.

Description	Command	Response
Event Control	C159*XXX 1 (Enable)	See Below
Event Control	C159*XXX 0 (Disable)	See Below

Parameters:
    - C159 is the default command name
    - XXX is the Event Number

Default:
    All events are disabled

Command Description: C160
Clear Analog High/Lows

This command allows you to reset the analog high/low readings. The readings can be read by speaking the appropriate word numbers (see appendix D).

Description	Command	Response
Clear High/Low	C160*I H L	See Below

Parameters:
- C160 is the default command name
- I is the I/O board number (1..2)
- H is 0 for the low alarm, 1 for the high alarm
- L is the I/O line on the I/O board

Command Description: C161
Set Analog Smoothing Factor

This command allows you to smooth the analog readings to "average out" noise and sudden changes.

Description	Command	Response
Event Control	C161*I L XX	See Below

Parameters:
- C161 is the default command name
- I is the I/O board number (1..2)
- L is the I/O line on the I/O board
- XX is the smoothing factor
    - 50 - "averages" over about 9 seconds
    - 60 - 13 seconds
    - 70 - 18 seconds
    - 80 - 30 seconds
    - 90 - 50 seconds
    - 95 - 120 seconds
    - 97 - 220 seconds
    - 98 - 325 seconds
    - 99 - 11 minutes

Advanced Command Description: C162
Always Send a Serial Message out the RLC-3 Port

This command is identical to command C032 except that it is "impolite", that is it sends its message whether you are using the serial port or not. This is useful for logging information with a serial printer, for making a modem call your number when you enter a DTMF command, etc.

Description	Command	Response
Sends Message	C162* Y .. Y	See Below

Parameters:
    - C162 is the default command name.
    - Y is the data to be sent over the RS-232 port
        -- The message length is limited to the maximum command length (about 100 characters) or if used in a macro, by the space left in a macro. If you need a longer message, split it up between several macros and use one macro to call the next macro in the sequence.

Voice response:
    There is no voice response for this command

Notes:
- To change the baud rate, see command C024.
- Serial output is normally queued (buffered) so that controller operation does not wait for the message to be sent before continuing. Queueing can be controlled with command C060.

Command Description: C163
Keypad Test

This command will read back whatever digits are entered. This allows you to check your DTMF keypad and make sure that the controller is accepting all of the digits. The EOF key (usually '*') must be entered after the command name as usual, and if entered again, will cause the controller to execute the command and speak all of the digits entered up to that point. The '*' character will be spoken as 'S' and '#' will be 'P'.

Description	Command	Response
Event Control	C163*X..X	See Below

Parameters:
- C163 is the default command name
- X..X are the digits to be read back

Command Description: C164
Select EOF-Entered Command

Commands that take data after the command name (like C000) are usually entered as
<command name> '*' <data> <unkey>, where the '*' is the EOF digit that indicates that you
are done entering the name and are now entering the data. Another example of this type of
command is C112, the forward dial autopatch command. Using it, you would normally enter
C112*<phone number> <unkey> to dial a number. To accommodate the many users that are
used to just pressing '*' and the phone number, this command can enter the name for them.
When the EOF digit (usually '*') is the first digit pressed after keying a receiver, the controller
will automatically enter the name of a command. Which command's name gets entered is
what you specify with this command. It defaults to a command that does nothing, but can be
set to enter the name of any command.

Description	Command	Response
Set EOF Cmd	C164*XXX	See Below
Default Cmd	C164*167	See Below

Parameters:
   - C164 is the default command name
   - XXX is the number of the command to be entered automatically (000..999)

Example:
   To make the '*' key automatically enter the forward dial autopatch command (command
number 112), enter C164*112*. Now to dial a number, you can simply key up and enter '*'
<phone number> <unkey>. Of course you can still dial a number the normal way with
C112*<phone number> <unkey>.

Advanced Command Description: C165
Reset COP Watchdog Timer

This command allows you to reset the COP watchdog timer from within a macro. The only time this should be needed is if you are executing an extremely long macro sequence (many macros calling each other). If such a macro sequence takes too long to execute, it will cause the controller to reset, because the controller thinks that something is wrong. Executing this command as part of such a long macro sequence will tell the controller that everything is ok, it is just taking a long time.

Description	Command	Response
Reset COP	C165*	See Below

Parameters:
    - C165 is the default command name

Command Description: C166
Display Status Screen

This command (when finished) will send formatted screens of information about the controller out of the serial port.

Description	Command	Response
Display Status	C166*X	See Below

Parameters:
    - C166 is the default command name
    - X is the number of the status screen to display

Command Description: C167
Do Nothing

This command does nothing. After executing, it returns an OK error code like most other commands do. It is used as the default command to execute for commands like C164.

Description	Command	Response
Do Nothing	C167	See Below

Parameters:
   - C167 is the default command name

Advanced Command Description: C168
Set DTMF Acceptance Requirements

This command allows you to choose what conditions must be true for received DTMF digits to be processed and used to execute commands.

The default setting is to accept DTMF digits if either or both the COR and PL signals are active, regardless of the receiver's access mode set with C005. If a port's access mode is "no access", it can still be controlled with DTMF commands. For example, suppose someone is causing problems on port 1 and you shut him off with C005*10*, setting the access mode to "no access". This will keep him from being able to key up any transmitters, even though he is getting into the receiver. When he gives up and goes away, you can make the receiver active again by entering C005*11* <u>on that receiver</u> (or any other receiver). Another example: you normally require PL to access your repeater but you want to make a PL override code that disables the PL requirement, so people that can't generate PL can still use the repeater.   With the DTMF requirements set to COR or PL, they will be able to execute the PL override command even though they can't key up the repeater without it.

The other possible setting requires that you satisfy whatever the port access conditions are (as set with C005) before your DTMF digits will be allowed to execute commands. This setting may be useful if there is another repeater in the area on the same frequency but using a different PL. If you use "COR and PL" as your access mode, all DTMF digits will be ignored unless the correct PL is being received.

Description	Command	Response
Set DTMF Req.	C168*PX*	X is On/Off

Parameters:
  - C168 is the default command name
  - P is the port number
  - X is 0 for "COR or PL", 1 to require the port to be active

Command Description: C169
Send Serial by ASCII Code Always

This command does the same thing as C162, but lets you enter characters by their ASCII codes rather than directly. This allows you to send characters that are not on the keyboard, or to send characters that are not on a DTMF pad when programming by DTMF. Each digit is specified by its three digit ASCII code, see Appendix H.

Description	Command	Response
Send ASCII	C169*CCC CCC ... CCC*	See Below

Parameters:
    - C169 is the default command name
    - CCC is the ASCII code for one serial character.

The Digital Voice Recorder

What the DVR is:

The optional DVR is a device that allows you to record sounds, store them in memory and play them at any time. It can be used to personalize your controller by recording any message or sounds that you want and playing them back for ID messages or in place of most other synthesized voice messages. Some of these messages are played in response to commands that you or the users enter; others are played at certain times, such as for an ID. Both types of messages will be described below.

DVR Tracks:

All DVR recordings are stored in numbered "tracks." Certain tracks have special purposes and are played automatically at certain times. Others are available for you to use in any way you wish. The length of each track is limited only by available memory. Each track uses only as much storage space as is actually needed.

The first 250 tracks (numbered 000..249) have no predetermined use - you may use them for ID messages, command responses (by calling C173 from a macro), or anything else you can think of. Tracks 250..260 or so are used for prompting. They are discussed further in the section below titled "Recording the Prompting Tracks". The remaining tracks are not directly accessible by number. They are used to support the mailbox features and are automatically accessed by the mailbox commands.

Public Mailboxes:

The DVR uses special internal tracks to provide two types of mailboxes: public and private. Both types allow you to leave messages for other repeater users. You can leave a message in a public mailbox by simply entering the "Leave Public Mail" command (after setting up the prompting tracks as described below). The DVR will then ask you who the mail is for. You key up and say their name or call sign. The DVR will then ask you to record your message. When you are through, it will tell you that your message has been stored. You can check if there is mail for you by simply entering the "Check Public Mail" command. It will list the names or call signs of the people that there is mail for, or will tell you that there is no mail. If there is mail for you, you can listen to your message by entering the "Retrieve Public Mail" command. Up to nine public mailboxes can be in use at a time.

Private Mailboxes:

Private mailboxes allow you to leave voice mail in someone's private mailbox. To do this you have to know the number of their mailbox. There are 1000 private mailboxes, so everyone in your club can have their own. Each private mailbox can hold up to five messages at a time. You can retrieve or delete the mail in your own mailbox without affecting anyone else's

mailbox.

Interfacing:

The DVR can be ordered with or without an optional rack mount cabinet. There is not enough room to mount it inside of the RLC-3 cabinet. Instead, there is a small interface board that plugs into the RLC-3 motherboard's "DVR Connection", near the power plug. This interface board should be installed with the chips and connector towards the edge of the RLC-3 motherboard (and the blank side of the interface circuit board toward the radio cards). A short ribbon cable connects this interface board to a DB-25 female connector that is mounted to a rectangular metal panel. This panel should be placed inside the cabinet behind the top horizontal rectangular cutout in the back of the cabinet. Four screws put into the corners of the panel from outside the cabinet hold it in place.

A DB-25 male-male cable (included) plugs into this connector and into the DVR. The only other required connection to the DVR is power (12 volts, center positive, plug included). Optional connections include a backup power plug that can be connected to a battery pack or another power supply (make sure ground is common between the supplies) to preserve the messages stored in the DVR if the main power goes out. The remaining connector can be connected to a computer or serial terminal (more about that later). Note that this serial port is separate from the serial port on the controller.

Memory Installation and Testing:

The DVR supports four different memory configurations, all using 80ns or faster standard 30 pin simms. Each configuration requires a different set of EPROMS in the DVR:

C   Two one megabyte simms (2 megabytes total)
C   Four one megabyte simms (4 megabytes total)
C   Two four megabyte simms (8 megabytes total)
C   Four four megabyte simms (16 megabytes total)

If only two simms are installed, they must be in the RAM #1 sockets. Note that all of the simms must be the same size. All of the memory is tested each time the DVR is powered up. If you want to see the results of the memory test, connect a computer or serial terminal to the DVR (it need not be connected to the RLC-3 at this time) and power up the DVR. You should see a printout on the serial screen noting how much memory is expected (based on which version of the EPROMS you have) and then how the memory test is progressing. If the DVR does not run at all, check the power and the serial connection. The DVR will attempt to run even if errors are detected during the memory test. If the memory test indicates that there are many errors, you may have the wrong size or number of simms installed, or the simms may be faulty. If there are only a few errors, you may be able to use the simms with errors in the RAM #2 sockets with only a slight loss of audio quality. Errors in the simms installed in the RAM #1 sockets are likely to cause serious problems.

The memory test performed when the DVR is powered up is very thorough and therefore can

take quite a while, especially if you have a lot of memory installed, so you may have to wait for it to finish before testing. With 2, 4, 8 and 16 megabytes of memory, the test takes about 20, 40, 80 and 160 seconds (about 2.5 minutes), respectively. Since you won't be powering up very often, this shouldn't be a problem.

Audio Quality/Recording Time:

The audio quality of tracks played with the DVR is nearly identical to the original. You will probably not be able to distinguish between a recording and someone talking "live." Technically, the DVR samples and plays audio at 8KHz with 8 bit resolution (256 voltage levels). This uses 64000 bits per second, which is 8000 bytes per second. At this rate, each megabyte of memory will hold 131 seconds of recorded audio. A small portion of the memory is used for other purposes, so the actual amount of storage will be slightly less than 131 seconds per megabyte. In a future software version, it may be possible to record with lower quality to extend the recording time.

Adjusting the DVR:

There are only two adjustments on the DVR: record level and playback level. Both are preset before the DVRs are shipped, and should not need to be changed, at least for initial testing. When/if you do decide to adjust the levels, the playback level should be set so that the audio is played back at the same volume it was when it was "live". If you decide to change the record level, the playback level should be adjusted again before any judgement is made as to whether the new record level is better or worse. The record level is important because it affects the quality of the recording. If it is set too low, the full resolution of the digital storage will not be utilized and there will be more background noise in the audio than is necessary. If the record level is set too high, the audio peaks will be clipped off and the audio will sound distorted, especially the loudest parts.

There are many factors that determine the best level, so experiment with the Audio Check Command and adjust the record level until it sounds the best. Looking at the audio with a scope as it is played back will help identify if the record level is set too loud, as the top and bottom of the waves will be flattened (a little bit of clipping on the louder parts is normal and expected). If you have a computer or serial terminal hooked up, you can also record a message with C171 and look at it with the software oscilloscope function to see how much of the available range you using.

The record and playback levels can be returned to the factory settings as follows: Set up a service monitor to generate a 1KHz tone with 3KHz deviation. Adjust the controller to get one volt peak to peak at the audio test point on the controller (the way the controller receive level is normally set up). Turn the generate function off. To make sure that the DVR is set up and working, use an HT to enter C170, unkey, key and say something, then unkey and listen. The DVR should play back whatever you said. If it does not, review the interfacing and testing sections above. Now key and enter C171*0, unkey, then turn the service monitor's generate function on. This will cause the DVR to record the 1KHz tone into track 0. Adjust the voltage at pin 1 of the DVR's audio test bus for one volt peak to peak. When you get it

adjusted or after 30 seconds (when the DVR will automatically quit recording), turn the generate function off and enter C174*0 to erase DVR track 0. Repeat entering C171*0, recording the tone and erasing it with C174*0 until you are satisfied that the record level is set, then record the 1KHz tone into DVR track 0 once more and don't erase it. Play it back by entering C173*0. While it is playing, adjust the voltage at pin 3 of the DVR's audio test bus for one volt peak to peak. C173*0 may be entered as many times as needed to get the level set. This sets the DVR to play back tracks at the exact same level they were recorded at. If the transmit level is set correctly on the controller, playing this track should cause about 3KHz of deviation. Finally, erase track 0 by entering C174*0.

The Audio Check Command:

Before executing any DVR commands on the RLC-3 you should enter C182*1 to tell the RLC-3 that the DVR is installed. The controller will respond by saying "one". If you do not do this, some of the commands will work, but others will not.

The easiest way to test the DVR is to execute the "Audio Check" command. To use it, simply key your radio and enter "C170", then unkey. Key up again and say something. When you unkey, the DVR will play whatever you said back to you, then erase it. If this command works, you have the DVR connected and working. You can execute this command as many times as you want to without harm and without wearing anything out. It can also be used to help you know if your signal is noisy into the repeater; just use this command to record a test message and you can listen to your own audio. Yet another use for this command is to find out how much record time (memory) is still available. To do this, start recording and count off the minutes and seconds you have been recording. When the DVR's memory is full, it will stop recording. When you unkey and the message is played back, you will hear yourself count as long as the DVR was able to record before it ran out of memory (this could take a long time if the memory is not almost full - if it takes too long, the max record length timer could stop it before the memory is full).

Recording DVR Tracks:

Before recording a track, you should make sure it is empty. If a track has already been recorded, you will not be able to record it again until you erase it. All tracks are empty when the DVR is powered up.

To record a track using COR to start and stop the recording, you should enter the record command followed by a '*' and the track number, "C171*TTT" (where TTT is the track number), then unkey (to tell the controller to execute that command and get ready to record). Then key up and start speaking your message. When you are finished, simply unkey. The DVR will automatically delete a fraction of a second of the beginning and end of your message to get rid of any noise caused by keying or unkeying.

If you wish to record a track without using COR, such as from the reverse autopatch in programming mode, you can use a DTMF digit to start and stop the recording. For example, to record track 0, you could enter "C171*000*". As soon as you release the second '*', the

DVR will begin recording. When you are finished speaking your message, press any DTMF digit to stop the recording. The DVR will automatically delete a fraction of a second at the end of your message to make sure that the sound of the DTMF digit is completely erased. Note that some phones (especially ones that can be used as speakerphones) mute about the first 1/2 second of each phrase you say; this makes recording nice DVR messages with them very difficult.

After you have recorded the prompting tracks (described later), you can use a more friendly version of the record command. C172 performs the same function as C171, but plays a DVR track that says something like "Please record you message now" after you enter the command and unkey (or press '*').

When recording using either the prompted or non-prompted command, you must start recording within 10 seconds of entering the record command and unkeying or you will have to enter the command again. This is so a record command can't be entered and end up recording someone that keys up an hour later not knowing that the record command was the last thing entered. The default 10 second window can be changed with command C020; it is the "DVR Start Recording Timer".

The only limit on the length of message that can be recorded is the amount of memory that is still available. To keep people from leaving long mailbox messages, timer 145 can be set to limit the length of message that can be left. It defaults to 30 seconds, but can be lengthened or shortened as desired using command C020. You may also need to lengthen your time out timer to record very long messages. Note that because some of the audio switching circuits are shared between the voice synthesizer and DVR, that only one may be playing at a time. If you play an exceptionally long DVR message, it may postpone the sending of synthesized voice IDs and other messages. For this reason, you should keep your DVR messages relatively short.

Playing Messages:

There are many things that can cause a DVR message to be played. For example, C170 records a message, then plays it back automatically. C172 plays a message to tell you to start recording a new message, then lets you record it. To simply play a message that has already been recorded, you can use C173. It works a lot like C036 does with the synthesized voice, playing the messages you request. C173 can be called from any macro to provide DVR IDs, courtesy beeps, autopatch off messages, etc.

Erasing Tracks:

There are several reasons to erase tracks. Tracks that have been recorded before must be erased before they can be recorded again. Tracks that are no longer being used should be erased to make more storage space available for new messages. Once a track has been erased, there is no way to recover it, so be careful when deleting tracks, especially when deleting a whole range at once. Deleting tracks can take several seconds, so don't be surprised if it takes a while before you hear the message erased message. If you are erasing a single message, the

controller will continue to run normally while it waits for the DVR to finish deleting the message and send "message erased". If you delete a range of DVR messages with one command, the controller will stop everything else it is doing while it tells the DVR to delete each of the tracks. When it is finished, the DVR will speak "message erased" to let you know it is finished.

Recording the Prompting Tracks:

There are several special messages that are played automatically at certain times. They should be recorded before attempting to use the prompted record command or the mailboxes. The messages shown below are only suggestions; you can record them to say anything you want them to. To record them, enter the commands and speak the messages shown below. For more information about recording tracks, see the "Recording Tracks" section above.

C171*250*   "Please record your message now"
C171*251*   "Your message is stored"
C171*252*   "Message erased"
C171*254*   "Who is your message for?"
C171*255*   "There are no messages."
C171*256*   "There is mail for..."

If you want to see how your messages sound, you can play most of them by entering C173*250<unkey> (for track 250). Message 256 can not be checked this way, so record it and don't worry about checking it until you try out command C175..C178. If you want to erase one of these tracks so you can record it again, enter C174*250<unkey> (to erase track 250). After recording these messages, the DVR is ready for use. Flip through the manual and try all of the commands until you are comfortable with them. If you want to erase all of your messages and start over, you can erase them with command C174 or you can unplug the DVR and controller for several seconds, then power them back up (and wait for the DVR to finish its memory test).

The Serial Interface:

The DVR includes a serial port for interfacing to a serial terminal or a computer running terminal software. This connection is not needed for normal operation, but it does provide some capabilities that are not available otherwise. Some of these are:

C   The messages in the DVR can be downloaded to a computer with a hard drive for backup, including the public and private mailboxes. In the event that both the main and backup power supplies fail and the DVR's memory is erased or you have to power down to install a software upgrade, you will be able to restore all of your messages. When the messages are downloaded, it is also relatively easy to edit out dead space at the beginning and end of messages. Please note that because the DVR has such a large amount of storage and because serial port transfers are relatively slow, that downloading takes a very very long time, like overnight. It can also take up to twice as much space on the hard drive as the amount of memory you have installed in the DVR.

C   A "software oscilloscope" function lets you view a graphical representation of what is stored in any one of the slots. This feature is not real-time and requires that your serial terminal or terminal emulation software supports ANSI cursor control commands (most do). This feature is useful for checking how much of the range of the analog to digital converter is being used.

C   A status display lets you check how much storage time is used for each message and mailbox. This can help you know what you should delete when the memory gets full.

If you have connected a terminal or computer to your RLC-3, all you have to do is unplug the cable from the RLC-3 and plug it into the DVR. The default setting is 9600 baud, N81, the same as the default for the RLC-3. If you do not already have a cable and your computer or serial terminal has a DB-9 connector, you can use a straight through DB-9 cable (not a null modem cable). If you are using a modem or TNC, note that pins 2 and 3 will have to be swapped (a null modem adapter will do this). If you are using a modem or TNC, you will probably have to set them up to make them work transparently - contact Link Communications if you need more information about how to do this.

If everything you type shows up double on your serial screen like this "tteesstt", turn the local echo off on your communications program.

The DVR is unavailable to the controller while it is executing a command entered from the serial port. Because of this, most of the serial commands will time out if you do not respond within about 10 seconds. Pressing the escape key will also get you out of most commands.

The default baud rate of 9600 baud works well for both uploading and downloading. Faster baud rates are supported, but may not work reliably. Downloading may work at a higher baud rate than uploading. When uploading, you may have to set the character pacing time (check the ASCII transfer settings on your communications program) to avoid overruns. The line pacing can be set relatively small, often to 0. When uploading at high baud rates, if the data that appears on your screen has missing or incorrect characters but you are not getting error messages, the data is probably being uploaded correctly and you can ignore the incorrect characters that you see on the screen. Most errors in uploading are caused by trying to upload to a track that is not empty. If the DVR is reset either by powering it down or by the serial reset commands, the baud rate is automatically reset to 9600 baud.

Command Description: C170
Record and Play Audio Test

This command makes the DVR start recording. When you unkey or press a DTMF digit to stop recording, it automatically plays it back. This is useful for testing the DVR and for checking how your signal sounds into the repeater. To use this command enter C170* and start speaking immediately, or enter C170 and unkey, then key up and start speaking. When through speaking, unkey and your recording will be played back immediately. The track is automatically erased after it is played back.

Description	Command	Response
Audio Test	C170	Plays recording

Parameters:
    - C170 is the default command name

Command Description: C171
Record DVR Track (non-prompted)

This command makes the DVR start recording a track. To use this command enter
C171*TTT* and start speaking immediately, or enter C171*TTT and unkey, then key up and
start speaking. Either way, you message will be recorded and stored in track TTT.

Description	Command	Response
Record Track	C171*TTT	Message Stored
Record Track	C171*T..T	Message Stored

Please note that a DVR track that has been recorded before must be erased before it can be
recorded again. This is to avoid accidently recording over an existing message.

Parameters:
- C171 is the default command name
- T..T is the DVR track number (1..3 digits, track 0..260)

Command Description: C172
Record DVR Track (prompted)

This command has the same result as C171: it records a DVR track. The difference is that after entering the command C172*TTT and unkeying, this command plays a special DVR track to tell you it is ready to start recording. This is useful because it lets you know that the command has been executed and the DVR is ready. After the prompting message is finished, you can key up and start recording. The disadvantage of this command compared with C171 is that you have to wait until the prompting message is finished before you can start recording. If you are recording a lot of tracks, it is faster to use C171.

Description	Command	Response
Record Track	C172*TTT	Message Stored
Record Track	C172*T..T	Message Stored

Please note that a DVR track that has been recorded before must be erased before it can be recorded again. This is to avoid accidently recording over an existing message.

Parameters:
- C172 is the default command name
- T..T is the DVR track number (1..3 digits, track 0..260)

Command Description: C173
Play DVR Tracks

This command makes the DVR start playing the specified track or tracks. They will be heard on the ports that are in the current audio routing variable (see Appendix A), just like the other commands that send tones or synthesized voice are. This is the command that you would use in an ID macro to send a DVR ID.

Description	Command	Response
Play Track	C173*TTT	
Play Track	C173*T..T	
Play Tracks	C173*TTT TTT ... TTT	

Parameters:
  - C173 is the default command name
  - TTT is a DVR track number. If only one track specified, can enter 1..3 digits. If more than one track is specified, must enter groups of three digits.

Command Description: C174
Erase DVR Tracks

This command makes the DVR erase the specified track or range of tracks. There are several reasons to erase tracks. Tracks that have been recorded before must be erased before they can be recorded again. Tracks that are no longer being used should be erased to make more storage space available for new messages. Once a track has been erased, there is no way to recover it, so use this command with caution, especially when erasing a range of tracks.

Description	Command	Response
Erase Track	C174*TTT	"message erased"
Erase Track	C174*T..T	"message erased"
Erase Tracks	C174*TTT FFF	"message erased"

Parameters:
- C174 is the default command name
- TTT is a DVR track number to be erased. If only specify one track can use 1..3 digits.
- FFF (optional). If specified, DVR tracks TTT through FFF will be erased. FFF must be larger than TTT.

Note: If the DVR track for "message erased" is not heard, make sure you have entered C182*1 to set up the DVR and that the "message erased" track has been recorded. You may have to wait for several seconds after entering the command for the DVR to finish deleting the message and send "message erased".

Command Description: C175
Record Public Mail

This command allows the user to record a message and who it is for and stores it in a public mailbox. It uses some of the special tracks to prompt the user to record the name or call sign and the message, and to tell him that the message has been stored. For more information, see the "Public Mailboxes" section at the beginning of the DVR section.

Description	Command	Response
Record Mail	C175	

Parameters:
    - C175 is the default command name

Command Description: C176
Check Public Mailboxes

This command recalls who has mail in the public mailboxes. The DVR will either play the special track that says, "There is mail for", then the name or call sign for each of the messages that are stored in the public mailboxes or it will play the special track, "There is no public mail". The names or call signs will be spoken in the order that the messages were recorded.

Description	Command	Response
Check Mail	C176	

Parameters:
    - C176 is the default command name

Command Description: C177
Retrieve Public Mail

This command allows a user that has mail in a public mailbox to retrieve it. This command is usually used after checking the public mailboxes with command C176. When you check the public mailboxes with C176, you should keep track of where your name or call sign are in the list of people that have mail. For example, if C176 says, "There is mail for Joe, Mary, Bob, Jim", and you are Bob, your mail will be stored in public mailbox #3, because your name is third in the list. To retrieve your mail, you would enter "C177*3".

Description	Command	Response
Retrieve Mail	C177*M*	

Parameters:
- C177 is the default command name
- M is which mailbox your mail is in (1..9)

Command Description: C178
Erase Public Mail

This command throws away the contents of a public mailbox, the last one that was retrieved. It must be used only after retrieving a public mailbox message with C177. It erases only the last public mailbox message that was retrieved; all of the others remain unchanged (although they may be moved up to a lower numbered mailbox to avoid leaving gaps).

Description	Command	Response
Erase Mail	C178*	

Parameters:
    - C178 is the default command name

Command Description: C179
Record Private Mail

This command allows the user to record a message and store it in a private mailbox. You must know the mailbox number you wish to leave a message in to use this command. Since each user has his own mailbox, there is no need for you to record his name or call sign as with the public mailboxes.

Description	Command	Response
Record Mail	C179*MMM	

Parameters:
    - C179 is the default command name
    - MMM is the number of the mailbox to leave the message in

Command Description: C180
Retrieve Private Mail

This command allows a user to retrieve the mail that has been left in his private mailbox. If he has no mail, the special DVR track "You have no mail" will be spoken. If there is more than one message in his mailbox, all of them will be spoken consecutively.

Description	Command	Response
Retrieve Mail	C180*MMM*	

Parameters:
  - C180 is the default command name
  - MMM is the number of the mailbox get the mail from

Command Description: C181
Erase Private Mail

This command throws away the contents of a private mailbox, the last one that was retrieved. It must be used only after retrieving a private mailbox message with C180. It erases all of the messages in that mailbox, but does not affect any of the other private mailboxes.

Description	Command	Response
Erase Mail	C181*	

Parameters:
    - C181 is the default command name

Command Description: C182
Select DVR Type

This command tells the RLC-3 what type, if any, DVR is installed. Some DVR commands will not work correctly if this command has not been executed. If no DVR is installed, this command should be used to tell the controller that.

Description	Command	Response
No DVR	C182*0	"zero"
Large DVR	C182*1	"one"

Macros

What a macro is:

There are at least two common understandings of what a macro is. The RLC-3 currently supports the more flexible of the two types; eventually it may support both. The kind the RLC-3 supports could be called a "multiple command macro" because it provides a way to execute a sequence of internal commands in response to one command from the user. In other words, this kind of macro contains a list of commands that are executed in order when the macro is executed. If you commonly want to connect your repeater port to a couple of link ports and turn DTMF muting on and change your courtesy beep, you could program a macro to execute the appropriate commands. This type of macro is very similar to the macros that many word processors and other computer programs allow you to make to automate things that you do often.

The other commonly used kind of macro (that the RLC-3 does not currently support) could be called a "snapshot macro". It allows you to set up the controller the way you like it, take a snapshot of it, and restore the controller to that configuration at any time by recalling the snapshot. While this may be convenient, it is also limiting. Consider an example: you and a buddy have two standalone repeaters running off of one RLC-3 controller. You are setting up one repeater and he is setting up the other. There are also two links running on the controller; we will call them Link A and Link B. You set up your repeater to be connected to Link A and take a snapshot. You then disconnect your repeater from Link A and connect it to Link B and take another snapshot. Now you can easily switch back and forth between the two configurations just by recalling the appropriate snapshot. The next day your buddy sets up his repeater port in a similar way. Now we start having problems. You want your repeater port to be connected to Link A, so you recall your snapshot. He wants to connect his repeater port to Link B so he recalls his snapshot. When he recalls his snapshot, it messes up your repeater port, changing it to whatever configuration it was in when he saved his snapshot. Neither of you can control your repeater ports independently of the other because the snapshots you saved don't just save the way one or two ports are set up, they save the way the whole controller is set up. This isn't a big problem with a simple controller with only one repeater port, but it gets very complicated when you start dealing with multiple repeaters and links.

The solution to the dilemma illustrated above is to use multiple command macros that do exactly what you want them to and nothing else. If you want a macro to connect you to Link A and not to Link B, make a multiple command macro to disconnect your repeater from Link B and connect it to Link A. Executing this macro will not interfere with anything else that is going on in the controller like a snapshot would.

Limits on Macros:

Since one macro can call another macro, you may wonder if macro 500 could call 501, which could call 502, which could call 503, etc. until you had called 100 macros or so. The answer is not quite. There are two limits. One is that if the total time it takes the processor to decode and execute the whole chained macro sequence is more than 1/2 second or so, the controller may reset itself. It is unlikely that you will ever reach this limit (it would probably take more than 20 macros all hooked together to even come close to this limit). The other limit restricts how deeply the macros can be *nested* (called from another macro). This is not a limit on how many commands can be called inside of a macro. It is not a limit on how many macros can be executed from one macro. It is a limit on one macro calling another macro that calls another macro that calls another macro. You can think of it as a limit on how deep an outline can go. For example, you execute macro 500. It calls command C038, macro 501, and command C000. This can be shown as the level with roman numerals:

    I   Call command C038
    II Call macro 501
    III Call command C000 and connect port 1 and 3

Macro 501 could contain command C007 and call macro 502. Since macro 501 is called from macro 500, it is *nested* one level deeper, to level 2. This could be shown as capital letters in the outline:

    I   Call command C038
    II Call macro 501
        A Call command C007
        B Call macro 502
    III Call command C000 and connect port 1 and 3

Macro 502 could call macros 503, 504 and 505. Macro 502 is nested one level deeper than 501, so it is at level 3.

    I   Call command C038
    II Call macro 501
        A Call command C007
        B Call macro 502
            1 Call macro 503
            2 Call macro 504
            3 Call macro 505
    III Call command C000 and connect port 1 and 3

Macros 503, 504 and 505 are at level 4. Note that they are all at the same level. Any commands that are called from these macros will be at level 5. This is about as deep as the RLC-3 will let you nest macros, 5 or 6 levels. If you ever exceed this limit, error macro 209 will be executed. This is the nested macro depth limit.

Command Description: C200..C499
Execute an Internal Macro

These commands allows you to manually recall program macro sequences. These sequences
are executed automatically by the controller to send IDs, courtesy beeps, alarm analog lines,
recall input conditions, etc. These macros are programmed the same way as user macros, but
are automatically called by the controller when certain events occur. You can also execute
them manually by entering the command name (C200 through C499). This is useful for
testing the macros to make sure that they are programmed they way you want them to be.

Description	Command	Response
Macro RCL	C200..C499	See Below

Parameters:
    - C200..C499 is the default command name.

See Appendix D for internal macro definitions.

Command Description: C500..C999
Execute a User Macro

These commands allow you to execute user macro sequences. These macro are not used by the controller for any specific purpose, so you can use them for any purpose.

Description	Command	Response
Macro RCL	C400..C999	See Below

Parameters:
    - C400..C999 is the default command name.

Appendix A
The Audio Routing Variable System

Explanation of the System

The key to controlling messages on the RLC-3 is understanding what the audio routing variable needs to be in each different situation. Fortunately, the RLC-3 does most of the work for you. When any command is executed by the user (either by DTMF or the serial port) or by the controller itself (to send an ID, courtesy beep, etc.), the audio routing variable is automatically set to send the audio to the logical place. You only need to concern yourself with this information if you wish to change the way the audio is routed. The value of the audio routing variable in several situations is listed below:

- When a command is executed by DTMF, the audio routing variable is set to send all of the responses to the port that the DTMF input came from.

- Before a time out, time out clear, or any ID macro is executed, the audio routing variable is set to send the message to the relevant port.

- Before a courtesy beep is sent, the audio routing variable is set to send the beeps to the right ports (repeater ports connected to the receiver that just unkeyed).

You probably noticed in the list above that the audio routing variable automatically sends the audio where you would normally want it to go. The only reason you need to know about it is because there a few situations where the controller can not know where you want the audio to go.

Suppose, for example, that you want the scheduler to cause the time to be read at the top of every hour. How could the controller know that you want only ports 1, 2 and 4 to hear the message? It can't. There are two ways for you to specify where messages from the scheduler go. First, choose where you want most of the messages caused by the scheduler to go. Tell the controller what ports those are with command C050. Now all of the messages caused by the scheduler will go out those ports. What if you want one of the messages caused by the scheduler to go somewhere else? Simply make the scheduler call a user macro and program the first command in the macro to be C037* and list the ports where you want the message to go to. This will change the audio routing variable for the rest of the commands in the macro. Command C037 can be used to change where the messages generated by any macro will go. All commands executed after C037 in a macro until the end of that macro will go to the ports specified with C037.

A similar situation exists for commands entered from the serial port. Since the controller sends serial responses to the commands that you execute, you don't have to worry about voice responses if you don't want to. There are times, however, when you want to hear the voice messages that are generated. You can use C050 to specify which ports get the audio that is caused by the serial port. The RLC-3 defaults to sending these messages out of port one, but

you can send them to any ports you want to, or to no ports at all (they will be thrown away).

C050 can also be used to control where the audio that is generated by the reset macro goes, although this same functionality could be achieved by just making C037 the first command in the reset macro.

Suppressing Command Responses in Macros:

There is one other time when you will often want to change the audio routing variable. Suppose that you have programmed macro 567 to connect ports 2 and 3 to the main repeater on port 1. Your macro would probably execute C000*12* and C000*13* to do this. The voice responses from these commands would be "1 connect 2 on, 1 connect 3 on". It wouldn't take very long to get tired of hearing that long message. To replace it with a nice short message like "link on" (word numbers 218 and 264), do the following:

> Insert command C038 (suppress audio) as the first command in the macro:

> C059*567 00 038

If you executed the macro at this point, it would be silent.

> Insert the new voice message even before that:

> C059*567 00 036 218 264

Now the macro will do the following:

> Speak the voice message "link on" (command number 036)

> Suppress the audio (set the audio routing variable to no ports, command number 038)

> Connect ports 1 and 2 (throws the voice responses away)

> Connect ports 1 and 3 (throws the voice responses away)

The same process can be used to suppress or change the voice response from any macro. Any commands that are executed after command C038 in a macro will be silent.

Appendix B
Voice Word Table

Romeo's words (words 000..543):

These words make up the main vocabulary of the controller. They are arranged with the numbers first, then the alphabet, then alphabetically.

Prefixes and Suffixes (words 544..552):

These are really parts of words. They can be used in combination with other words to make some new words. For example, you can use words 311 and 549 together to form the word "meetings".

Juliet's words (words 553..586):

These are used primarily for time and date. They are not intended to allow you to run the whole controller with the female voice.

Pause (word 587):

Word 587 is listed as "pause". It causes the voice to pause for a moment, such as between sentences. It does not speak the word "pause". It can be used in combination with any of the other words.

Sound Effects (words 588..598):

Try them!!!

Junior's words (599..685):

Romeo quit the recording business, so we had to get Junior to record some other words for us. Some words were recorded by by both Romeo and Junior, so you might want to check both places in the word list. It usually sounds best if you don't mix words from the two lists in one message, but sometimes that is the only way to get the words you want.

Variable words (810..919):

Most of these words allow you to insert a message that is not always the same into a voice message, such as the current time. If you want to include the time in one of your IDs, for example, you could just include word 810 in the ID message. "At <the time>, this-is the XXXXX repeater" would be word numbers 086, 810, 480, 475, 054, 054, 054, 054, 054, 411. These words make it easy to write custom messages that read the time, date, I/O lines, etc.

Word List:

Romeo's Words

000 ZERO	042 L	086 AT
001 ONE	043 M	087 AUGUST
002 TWO	044 N	088 AUTO
003 THREE	045 O	089 AUTOMATIC
004 FOUR	046 P	090 AUTOPILOT
005 FIVE	047 Q	091 AUXILIARY
006 SIX	048 R	092 AVON
007 SEVEN	049 S	093 AVON MOUNTAIN
008 EIGHT	050 T	094 A.M.
009 NINE	051 U	095 BAND
010 TEN	052 V	096 BANK
011 ELEVEN	053 W	097 BASE
012 TWELVE	054 X	098 BATTERY
013 THIRTEEN	055 Y	099 BELOW
014 FOURTEEN	056 Z	100 BETWEEN
015 FIFTEEN	057 ABORT	101 BLOWING
016 SIXTEEN	058 ABOUT	102 BLUE KNOB
017 SEVENTEEN	059 ABOVE	103 BOARD
018 EIGHTEEN	060 ACKNOWLEDGE	104 BOOST
019 NINETEEN	061 ACTION	105 BOZO
020 TWENTY	062 ADJUST	106 BRAKE
021 THIRTY	063 ADVANCED	107 BRAVO
022 FORTY	064 ADVISE	108 BREAK
023 FIFTY	065 AERIAL	109 BROKEN
024 SIXTY	066 AFFIRMATIVE	110 BUSY
025 SEVENTY	067 AIR	111 BUTTON
026 EIGHTY	068 AIRPORT	112 BY
027 NINETY	069 AKRON	113 CABIN
028 HUNDRED	070 ALERT	114 CALIBRATE
029 THOUSAND	071 ALL	115 CALL
030 MILLION	072 ALOFT	116 CALLING
031 A	073 ALPHA	117 CALM
032 B	074 ALTERNATE	118 CANCEL
033 C	075 ALTITUDE	119 CAUTION
034 D	076 AMATEUR	120 CEILING
035 E	077 AMPS	121 CELSIUS
036 F	078 AND	122 CENTER
037 G	079 ANSWER	123 CHANGE
038 H	080 APPROACH	124 CHARLIE
039 I	081 APRIL	125 CHECK
040 J	082 AREA	126 CIRCUIT
041 K	083 ARRIVAL	127 CLEAR
	084 AS	128 CLIMB
	085 ASSOCIATION	129 CLOCK

130 CLOSED	176 EAST	223 GLIDE
131 CLUB	177 ECHO	224 GO
132 CODE	178 ELECTRICIAN	225 GOLF
133 COLUMBUS	179 ELEVATION	226 GOODBYE
134 COME	180 EMERGENCY	227 GREEN
135 COMPLETE	181 ENGINE	228 GREENWICH
136 COMPUTER	182 ENTER	229 GROUND
137 CONDITION	183 EQUAL	230 GURNEE
138 CONGRATULATIONS	184 EQUALS	231 GUSTINGTO
139 CONNECT	185 ERROR	232 HAIL
140 CONNECTICUT	186 ESTIMATED	233 HALF
141 CONTACT	187 EVACUATE	234 HAM
142 CONTROL	188 EVACUATION	235 HAMFEST
143 CONVERGING	189 EXIT	236 HAMVENTION
144 COSHOCTON	190 EXPECT	237 HAVE
145 COUNT	191 FAIL	238 HAZARDOUS
146 COURSE	192 FAILURE	239 HAZE
147 CRANE	193 FARAD	240 HEAVY
148 CROSSWIND	194 FARENHEIT	241 HELLO
149 CURRENT	195 FARMINGTON	242 HELP
150 CUYAHOGA FALLS	196 FAST	243 HENRY
151 CYCLE	197 FEBRUARY	244 HERTZ
152 DALLAS	198 FEET	245 HIGH
153 DANGER	199 FILED	246 HOLD
154 DATE	200 FINAL	247 HOME
155 DAY	201 FINDLAY	248 HOTEL
156 DAYS	202 FIRE	249 HOUR
157 DAYTON	203 FIRST	250 HOURS
158 DECEMBER	204 FLAPS	251 ICE
159 DECREASE	205 FLIGHT	252 ICING
160 DECREASING	206 FLOW	253 IDENTIFY
161 DEGREES	207 FOG	254 IGNITE
162 DELTA	208 FOR	255 IGNITION
163 DEPARTURE	209 FOURTH	256 IMMEDIATELY
164 DEVICE	210 FOXTROT	257 IN
165 DIAL	211 FREEDOM	258 INBOUND
166 DINNER	212 FREEZING	259 INCH
167 DIRECTION	213 FREQUENCY	260 INCREASE
168 DISPLAY	214 FRIDAY	261 INCREASING
169 DIVIDED	215 FROM	262 INCREASINGTO
170 DOOR	216 FRONT	263 INDIA
171 DOWN	217 FULL	264 INDICATED
172 DOWNWIND	218 GALLONS	265 INFLIGHT
173 DRIVE	219 GATE	266 INFORMATION
174 DRIZZLE	220 GAUGE	267 INNER
175 DUST	221 GEAR	268 INSPECTOR
	222 GET	269 INTRUDER

270 IS	317 MILES	364 OUT
271 IT	318 MILL	365 OUTER
272 JANUARY	319 MILLI	366 OVER
273 JULIET	320 MINUS	367 OVERCAST
274 JULY	321 MINUTES	368 PAPA
275 JUNE	322 MIST	369 PARTIALLY
276 KENTUCKY	323 MOBILE	370 PASS
277 KEY	324 MODERATE	371 PASSED
278 KILO	325 MONDAY	372 PATCH
279 KNOTS	326 MONTH	373 PATH
280 LAND	327 MORETHAN	374 PELLETS
281 LANDING	328 MOTOR	375 PER
282 LATE	329 MOUNT HAMILTON	376 PERCENT
283 LAUNCH	330 MOUNT TAMALPAIS	377 PHONE
284 LEAN	331 MOVE	378 PICO
285 LEFT	332 MOVING	379 PLEASE
286 LEG	333 MUCH	380 PLUS
287 LESS THAN	334 NEAR	381 POINT
288 LEVEL	335 NEGATIVE	382 POLICE
289 LIGHT	336 NET	383 POSITION
290 LIMA	337 NEW	384 POWER
291 LINE	338 NEWINGTON	385 PRACTICE
292 LINK	339 NEW HAVEN	386 PRESS
293 LIST	340 NEXT	387 PRESSURE
294 LITTON	341 NIGHT	388 PRIVATE
295 LOCK	342 NO	389 PROBE
296 LONG	343 NORTH	390 PROGRAMMING
297 LOOK	344 NORTHEAST	391 PULL
298 LOW	345 NORTHWEST	392 PUSH
299 LOWER	346 NOT	393 P.M.
300 LUNCH	347 NOVEMBER	394 QUEBEC
301 MACHINE	348 NUMBER	395 RADAR
302 MAINTAIN	349 OAKS	396 RADIO
303 MANUAL	350 OBSCURED	397 RAIN
304 MARCH	351 O'CLOCK	398 RAISE
305 MARKER	352 OCTOBER	399 RANGE
306 MAY	353 OF	400 RATE
307 MAYDAY	354 OFF	401 RATTLESNAKE
308 ME	355 OHIO	MOUNTAIN
309 MEAN	356 OHMS	402 READY
310 MEASURE	357 OIL	403 REAR
311 MEETING	358 ON	404 RECEIVE
312 MEGA	359 OPEN	405 RED
313 MESSAGES	360 OPERATION	406 RELEASE
314 METER	361 OPERATOR	407 REMARK
315 MICRO	362 OSCAR	408 REMOTE
316 MIKE	363 OTHER	409 REPAIR

410 REPEAT	457 STOP	504 UNIT
411 REPEATER	458 STORM	505 UNLIMITED
412 RICH	459 SUNDAY	506 UNTIL
413 RICHMOND	460 SWITCH	507 UP
414 RIG	461 SYSTEM	508 USE (NOUN)
415 RIGHT	462 TANGO	509 USE (VERB)
416 ROAD	463 TANK	510 VALLEY
417 ROGER	464 TARGET	511 VALVE
418 ROMEO	465 TARPON SPRINGS	512 VARIABLE
419 ROUTE	466 TAXI	513 VERIFY
420 RUNWAY	467 TEEN	514 VICTOR
421 SAFE	468 TELEPHONE	515 VISIBILITY
422 SAINT PETERSBURG	469 TEMPERATURE	516 VOLTS
423 SAND	470 TERMINAL	517 WAIT
424 SANTA CLARA	471 TEST	518 WAKE
425 SAN LEANDRO	472 THANK YOU	519 WAKEUP
426 SATURDAY	473 THAT	520 WARNING
427 SCATTERED	474 THE (LONG E)	521 WATCH
428 SECOND	475 THE (SHORT E)	522 WATTS
429 SECONDS	476 THE	523 WAY
430 SECURITY	477 THIN	524 WEATHER
431 SELECT	478 THINLY	525 WEDNESDAY
432 SEPTEMBER	479 THIRD	526 WELCOME
433 SEQUENCE	480 THIS IS	527 WEST
434 SERVICE	481 THIS	528 WEST HARTFORD
435 SET	482 THUNDERSTORMS	529 WHISKEY
436 SEVERE	483 THURSDAY	530 WILL
437 SEXY	484 TIME	531 WIND
438 SHORT	485 TIMER	532 WISKEY
439 SHOWERS	486 TIMES	533 WITH
440 SHUT	487 TO	534 WRONG
441 SIDE	488 TODAY	535 X-RAY
442 SIERRA	489 TOMORROW	536 YANKEE
443 SIGHT	490 TONIGHT	537 YELLOW
444 SLEET	491 TOOL	538 YESTERDAY
445 SLOPE	492 TORNADO	539 YOU
446 SLOW	493 TORONTO	540 YOUR
447 SMOKE	494 TOUCHDOWN	541 ZED
448 SNOW	495 TOWER	542 ZONE
449 SOUTH	496 TRAFFIC	543 ZULU
450 SOUTHEAST	497 TRANSMIT	
451 SOUTHWEST	498 TRIM	***Prefixes and Suffixes***
452 SPEED	499 TUESDAY	
453 SPRAY	500 TURBULANCE	544 FIF-
454 SQUAWK	501 TURN	545 THIR-
455 STALL	502 UNDER	546 -ED
456 START	503 UNIFORM	547 -ER

548 -ING
549 -S
550 -TEEN
551 -TH
552 -TY

Juliet's Words

553 OH
554 ONE
555 TWO
556 THREE
557 FOUR
558 FIVE
559 SIX
560 SEVEN
561 EIGHT
562 NINE
563 TEN
564 ELEVEN
565 TWELVE
566 THIRTEEN
567 FOURTEEN
568 FIFTEEN
569 SIXTEEN
570 SEVENTEEN
571 EIGHTEEN
572 NINETEEN
573 TWENTY
574 THIRTY
575 FORTY
576 FIFTY
577 GOOD
578 MORNING
579 AFTERNOON
580 EVENING
581 THE
582 TIME
583 IS
584 A.M.
585 P.M.
586 O'CLOCK

Pause

587 PAUSE

Sound Effects

588 LASER
589 WHISTLE
590 PHASER
591 TRAIN
592 EXP
593 CROWD
594 TIC
595 TOC
596 HIGH-LOW TONE
597 LOW-HIGH TONE
598 HIGH TONE

Junior's Words

599 ALARM
600 AMATEUR
601 ANALOG
602 ARIZONA
603 AUTOPATCH
604 BACHELOR
605 BAD
606 BASE
607 BATTERY
608 BAY
609 BILLINGS
610 BOZEMAN
611 CANOE
612 CAPROCK
613 CENTRAL
614 CHARGING
615 CLOUDS
616 CLUB
617 COMMUNICATIONS
618 CONTROLLER
619 DIGITAL
620 EMPIRE
621 EVENT
622 FIELD
623 FLASH
624 FLOOD
625 FRIENDLY
626 GOLDEN
627 GREYCLIFF
628 HAM

629 HAMFEST
630 HARRISON
631 HOLLEY
632 HOME
633 INFORMATION
634 INLAND
635 INPUT
636 INSIDE
637 KOOTENAI
638 LINK
639 LITTLEROCK
640 MEDIUM
641 MEETING
642 MICA
643 MONITOR
644 MOUNTAIN
645 NET
646 OBED
647 OREGON
648 OUTSIDE
649 PEAK
650 POUND
651 PUMP
652 PYRAMID
653 RACES
654 RADIO
655 RATTLESNAKE
656 REMOTE
657 REPEATER
658 RIDGE
659 SANDRA
660 SCAN
661 SIDNEY
662 SKYWARN
663 SOCIETY
664 SPOKANE
665 STAR
666 STATE
667 SUNDANCE
668 SYSTEM
669 TACOMA
670 THIS
671 TIGER
672 TODAY
673 TOMORROW
674 TONIGHT
675 VALUE

676 VOLTAGE
677 WASHINGTON
678 WATCH
679 WATER
680 WELCOME
681 WITH
682 YAKIMA
683 YELLOWHEAD
684 YELLOWKNIFE
685 ZED

Internal Variable Words (don't use these)

800 UNUSED
801 START POLITE
802 END POLITE
803 END POLITE DO CMD
804 DO DELAYED DIAL
805 START DVR TIMER

User Variable Words

810 TIME
811 HOUR OF DAY (12 hr)
812 HOUR OF DAY (24 hr)
813 MINUTE OF HOUR
814 AM/PM
815 DATE
816 MONTH OF YEAR
817 DAY OF MONTH
818 YEAR
819 DAY OF WEEK
830 TIME (FEMALE)
831 HOUR OF DAY (12 hr) (FEMALE)
832 HOUR OF DAY (24 hr) (FEMALE)
833 MINUTE OF HOUR (FEMALE)
834 AM/PM (FEMALE)

835 MORN/AFT/EVE (FEMALE)
840 I/O 1 ANALOG 1
841 I/O 1 ANALOG 2
842 I/O 1 ANALOG 3
843 I/O 1 ANALOG 4
844 I/O 1 ANALOG 5
845 I/O 1 ANALOG 6
846 I/O 1 ANALOG 7
847 I/O 1 ANALOG 8
848 I/O 2 ANALOG 1
849 I/O 2 ANALOG 2
850 I/O 2 ANALOG 3
851 I/O 2 ANALOG 4
852 I/O 2 ANALOG 5
853 I/O 2 ANALOG 6
854 I/O 2 ANALOG 7
855 I/O 2 ANALOG 8
856 I/O 1 HIGH 1
857 I/O 1 HIGH 2
858 I/O 1 HIGH 3
859 I/O 1 HIGH 4
860 I/O 1 HIGH 5
861 I/O 1 HIGH 6
862 I/O 1 HIGH 7
863 I/O 1 HIGH 8
864 I/O 2 HIGH 1
865 I/O 2 HIGH 2
866 I/O 2 HIGH 3
867 I/O 2 HIGH 4
868 I/O 2 HIGH 5
869 I/O 2 HIGH 6
870 I/O 2 HIGH 7
871 I/O 2 HIGH 8
872 I/O 1 HIGH TIME 1
873 I/O 1 HIGH TIME 2
874 I/O 1 HIGH TIME 3
875 I/O 1 HIGH TIME 4
876 I/O 1 HIGH TIME 5
877 I/O 1 HIGH TIME 6
878 I/O 1 HIGH TIME 7
879 I/O 1 HIGH TIME 8
880 I/O 2 HIGH TIME 1
881 I/O 2 HIGH TIME 2
882 I/O 2 HIGH TIME 3
883 I/O 2 HIGH TIME 4
884 I/O 2 HIGH TIME 5

885 I/O 2 HIGH TIME 6
886 I/O 2 HIGH TIME 7
887 I/O 2 HIGH TIME 8
888 I/O 1 LOW 1
889 I/O 1 LOW 2
890 I/O 1 LOW 3
891 I/O 1 LOW 4
892 I/O 1 LOW 5
893 I/O 1 LOW 6
894 I/O 1 LOW 7
895 I/O 1 LOW 8
896 I/O 2 LOW 1
897 I/O 2 LOW 2
898 I/O 2 LOW 3
899 I/O 2 LOW 4
900 I/O 2 LOW 5
901 I/O 2 LOW 6
902 I/O 2 LOW 7
903 I/O 2 LOW 8
904 I/O 1 LOW TIME 1
905 I/O 1 LOW TIME 2
906 I/O 1 LOW TIME 3
907 I/O 1 LOW TIME 4
908 I/O 1 LOW TIME 5
909 I/O 1 LOW TIME 6
910 I/O 1 LOW TIME 7
911 I/O 1 LOW TIME 8
912 I/O 2 LOW TIME 1
913 I/O 2 LOW TIME 2
914 I/O 2 LOW TIME 3
915 I/O 2 LOW TIME 4
916 I/O 2 LOW TIME 5
917 I/O 2 LOW TIME 6
918 I/O 2 LOW TIME 7
919 I/O 2 LOW TIME 8

Appendix C
CW Code Table

CW Code Table

00	–	0	13	–	D	26	–	Q	39	–	AR
01	–	1	14	–	E	27	–	R	40	–	SPACE
02	–	2	15	–	F	28	–	S	41	–	PAUSE
03	–	3	16	–	G	29	–	T			
04	–	4	17	–	H	30	–	U			
05	–	5	18	–	I	31	–	V			
06	–	6	19	–	J	32	–	W			
07	–	7	20	–	K	33	–	X			
08	–	8	21	–	L	34	–	Y			
09	–	9	22	–	M	35	–	Z			
10	–	A	23	–	N	36	–	/			
11	–	B	24	–	O	37	–	.			
12	–	C	25	–	P	38	–	?			

Appendix D
Automatic Macros

The following is a list of the macros that are automatically executed by the controller at certain times. Because they are executed automatically when something happens (like a timer expiring) rather than because a user specifically told it to execute by entering the macros name, they are called "automatic" macros. The only difference between automatic and user macros is who (or what) decides that they should be executed. They are named according to the function that they usually perform. If you want to change how something works, you can change what commands the macro executes to suit your own desires. An example of this would be changing an impolite ID macro to send your repeater's ID rather than the example ID that is programmed in at the factory.

You can execute any of these macros by entering its name, which is "C" and then the macro's number and a "*" (example C200*). This is useful for finding out what is already in the macros. You find out even more about what is in a macro by recalling its contents with command C054* then the macro's number. If you do this from a serial terminal, it will be relatively easy to understand. If you do it from a DTMF pad, the voice message may seem long and complicated. This is because the synthesized voice must spell out the messages that are programmed in the macros. You can learn a lot about how the controller works by looking at what is inside of the macros with C054. C054 also tells you how many percent full a macro is. Each macro can store 100 bytes of information, about 100 keystrokes.

Automatic Macro Explanations

Macros 200..219 are where your error messages come from. Whenever an error occurs in the controller, it will cause one of these macros to be executed. To find out what caused the error, remember what the error number is and look at the description of the corresponding macro number below. You can change the error messages to say anything you want them to, or nothing at all, by changing these macros. Please note, however, that if you remove the error messages completely, that you may not be able to tell when an error occurs.

Macros 220..267. These macros are automatically called when it is time to send an ID. You will want to erase (with command C055) what is in these macros when you get the controller and put your own ID messages in these macros. It would be worth your time to study the way these IDs are programmed at the factory (see command C054) so that you can make yours work the same way. Note that command C064 is used to speak the voice IDs so that they will be polite and will automatically call the impolite ID macro (which is usually CW) if they are interrupted. Shortcut: if you want all four of the pending IDs for a port to send the same message, program that message in the first of the four pending id macros, then program the other three to execute the first one. To change the ID timers, see command C020.

Macros 268..275 are executed when it is time to send a courtesy beep. You would normally call command C040 from this macro to generate the tones of your courtesy beep. If you want your courtesy beep to contain several beeps in sequence, you can call C040 multiple times within one macro, once for each beep.

In case you were wondering, before this macro is automatically called after you unkey, the audio routing variable is set to make the tones go to the proper ports, so you do not have to worry about that at all. Just call the commands you want to be executed when it is time for a courtesy beep (you could send beeps, DTMF digits, voice messages...) and the audio will automatically be sent to the correct ports. To change the courtesy beep timers, see command C020.

Macros 276..291 are called when Analog 1..16 go into a High alarm. You may want to use these macros to speak an voice message indicating the alarm and/or take some other action such as turning off an output line. To change how often the RLC-3 checks to see if an alarm has occured, see command C020. The default is every one second.

Macros 292..307 are called when Analog 1..16 go into a Low alarm. You may want to use these macros to indicate an alarm condition.

Macros 308..323 are called when Analog 1..16 go out of either High or Low alarm into a Normal condition. You may want to use these macros to indicate that the analog reading is no longer causing an alarm.

Macros 324..339 are called when Input 1..16 goes from Low to High. You may want to use these macros to indicate an alarm condition.

Macros 340..355 are called when Input 1..16 goes from High to Low. You may want to use these macros to indicate an alarm condition.

Macros 356..363 are called when the Time-Out Timer expires. You may want to program these messages to indicate when a time-out condition occurred. Currently, the RLC-3's software shuts off the transmitter immediately when a time out condition occurs, so any messages generated by this macro will not be sent until the time out condition is cleared. This problem will be fixed in a future software release. For now, do not attempt to speak anything from these macros. To adjust the time out timers, see command C020.

Macros 364..371 are called when the Time-Out Timer comes out of a time-out condition. You may want to program these messages to indicate that a time-out condition has just been cleared.

Macros 372..387. If you don't use preaccess, you can totally ignore these macros. Even if you do use preaccess, you don't have to worry about them. They are automatically renamed and programmed when you configure a port for preaccess with command C070 or C071. If you are curious, however, read on. When a port is set to require preaccess (either with command C070 or C071), these macros are automatically programmed and renamed. The access code ("*" for a repeater, "#??" for a link) is actually the new name of these macros. Also, the command decoder is told to ignore every command that is entered from that port except for these macros. When you enter the access code, one of these macros is executed. The commands that are automatically programmed into these macros may do a lot of things (such as start dial tone for a link), but they always do this one thing, they execute command C074. C074 tells the command decoder to let that port access all of the commands in the controller again, but only until the preaccess timer (see command C020) runs out.

You should never have to change the contents of these macros by hand (since C070 and C071 do the work for you), but you might want to change their names. When you use C070 to configure a port as a preaccess repeater, it assumes that you want the local-mode access code to be "*". If that is not true, you can simply rename the first preaccess macro for that port to something else. Similarly, the link access code that is usually "#" plus two digits, can be changed to any valid command name up to six digits long.

Macro 388 is called whenever the controller is reset, whether it is reset because the power was just turned on, because you pressed the reset button, or because you executed the remote reset command. You can use it to execute any commands that you want to be executed on reset. If you run out of space in this, or any other macro, because you are trying to do to much, just call another macro, or several of them, from this macro and split up the work.

Macro 389 is a temporary macro that is used when appending macros etc. It is of no use to you because it will be overwritten often.

Macros 390..397 are called when the COR input for the corresponding port goes active. They are not normally used, but are provided for users that have a special purpose for them. A more general and flexible method of calling macros when a certain condition inside the controller is met is planned for a future release.

Macros 398..405 are called when the PL input for the corresponding port goes active. They are not normally used, but are provided for users that have a special purpose for them. A more general and flexible method of calling macros when a certain condition inside the controller is met is planned for a future release.

Macros 406..421 are called when the corresponding user timer (see command C020) expires. These timers can be started with command C022 and stopped with C023. They are not normally used, but are provided for users that have a special purpose for them. A more general and flexible system of user-definable timers is planned for a future release.

Macros 422..499 are reserved for future automatic macros. You may use them in a pinch, but they may get assigned to an automatic function in a future software update.

Automatic Macro Numbers

200 - Cmd Name Length not Matched
201 - Command Name not Found
202 - Execution Blocked
203 - Extra Data too Long
204 - Extra Data too Short
205 - Command Name Decoded OK
206 - Command Executed OK
207 - Internal Error - Null Macro Ptr
208 - Internal Error - Null Function Ptr
209 - Nested Macro Depth Limit Reached
210 - Invalid Variable Length Data Length
211 - Invalid Value Entered
212 - Command Doesn't Exist
213 - Bad Autopatch Number
214 - Reserved
215 - Reserved
216 - Reserved
217 - Reserved
218 - Reserved
219 - Reserved
220 - Initial ID Port 1
221 - Initial ID Port 2
222 - Initial ID Port 3
223 - Initial ID Port 4
224 - Initial ID Port 5
225 - Initial ID Port 6
226 - Initial ID Port 7
227 - Initial ID Port 8
228 - Pending ID #1 Port 1
229 - Pending ID #1 Port 2
230 - Pending ID #1 Port 3
231 - Pending ID #1 Port 4
232 - Pending ID #1 Port 5
233 - Pending ID #1 Port 6
234 - Pending ID #1 Port 7
235 - Pending ID #1 Port 8
236 - Pending ID #2 Port 1
237 - Pending ID #2 Port 2
238 - Pending ID #2 Port 3
239 - Pending ID #2 Port 4
240 - Pending ID #2 Port 5
241 - Pending ID #2 Port 6
242 - Pending ID #2 Port 7
243 - Pending ID #2 Port 8
244 - Pending ID #3 Port 1

245 - Pending ID #3 Port 2
246 - Pending ID #3 Port 3
247 - Pending ID #3 Port 4
248 - Pending ID #3 Port 5
249 - Pending ID #3 Port 6
250 - Pending ID #3 Port 7
251 - Pending ID #3 Port 8
252 - Pending ID #4 Port 1
253 - Pending ID #4 Port 2
254 - Pending ID #4 Port 3
255 - Pending ID #4 Port 4
256 - Pending ID #4 Port 5
257 - Pending ID #4 Port 6
258 - Pending ID #4 Port 7
259 - Pending ID #4 Port 8
260 - Impolite ID Port 1
261 - Impolite ID Port 2
262 - Impolite ID Port 3
263 - Impolite ID Port 4
264 - Impolite ID Port 5
265 - Impolite ID Port 6
266 - Impolite ID Port 7
267 - Impolite ID Port 8
268 - Courtesy Beep Command Slot Port 1
269 - Courtesy Beep Command Slot Port 2
270 - Courtesy Beep Command Slot Port 3
271 - Courtesy Beep Command Slot Port 4
272 - Courtesy Beep Command Slot Port 5
273 - Courtesy Beep Command Slot Port 6
274 - Courtesy Beep Command Slot Port 7
275 - Courtesy Beep Command Slot Port 8
276 - I/O #1 Analog High Alarm #1
277 - I/O #1 Analog High Alarm #2
278 - I/O #1 Analog High Alarm #3
279 - I/O #1 Analog High Alarm #4
280 - I/O #1 Analog High Alarm #5
281 - I/O #1 Analog High Alarm #6
282 - I/O #1 Analog High Alarm #7
283 - I/O #1 Analog High Alarm #8
284 - I/O #2 Analog High Alarm #1
285 - I/O #2 Analog High Alarm #2
286 - I/O #2 Analog High Alarm #3
287 - I/O #2 Analog High Alarm #4
288 - I/O #2 Analog High Alarm #5
289 - I/O #2 Analog High Alarm #6

290 - I/O #2 Analog High Alarm #7
291 - I/O #2 Analog High Alarm #8
292 - I/O #1 Analog Low Alarm #1
293 - I/O #1 Analog Low Alarm #2
294 - I/O #1 Analog Low Alarm #3
295 - I/O #1 Analog Low Alarm #4
296 - I/O #1 Analog Low Alarm #5
297 - I/O #1 Analog Low Alarm #6
298 - I/O #1 Analog Low Alarm #7
299 - I/O #1 Analog Low Alarm #8
300 - I/O #2 Analog Low Alarm #1
301 - I/O #2 Analog Low Alarm #2
302 - I/O #2 Analog Low Alarm #3
303 - I/O #2 Analog Low Alarm #4
304 - I/O #2 Analog Low Alarm #5
305 - I/O #2 Analog Low Alarm #6
306 - I/O #2 Analog Low Alarm #7
307 - I/O #2 Analog Low Alarm #8
308 - I/O #1 Analog Alarm to Normal #1
309 - I/O #1 Analog Alarm to Normal #2
310 - I/O #1 Analog Alarm to Normal #3
311 - I/O #1 Analog Alarm to Normal #4
312 - I/O #1 Analog Alarm to Normal #5
313 - I/O #1 Analog Alarm to Normal #6
314 - I/O #1 Analog Alarm to Normal #7
315 - I/O #1 Analog Alarm to Normal #8
316 - I/O #2 Analog Alarm to Normal #1
317 - I/O #2 Analog Alarm to Normal #2
318 - I/O #2 Analog Alarm to Normal #3
319 - I/O #2 Analog Alarm to Normal #4
320 - I/O #2 Analog Alarm to Normal #5
321 - I/O #2 Analog Alarm to Normal #6
322 - I/O #2 Analog Alarm to Normal #7
323 - I/O #2 Analog Alarm to Normal #8
324 - I/O #1 Input Line High #1
325 - I/O #1 Input Line High #2
326 - I/O #1 Input Line High #3
327 - I/O #1 Input Line High #4
328 - I/O #1 Input Line High #5
329 - I/O #1 Input Line High #6
330 - I/O #1 Input Line High #7
331 - I/O #1 Input Line High #8
332 - I/O #2 Input Line High #1
333 - I/O #2 Input Line High #2
334 - I/O #2 Input Line High #3
335 - I/O #2 Input Line High #4
336 - I/O #2 Input Line High #5

337 - I/O #2 Input Line High #6
338 - I/O #2 Input Line High #7
339 - I/O #2 Input Line High #8
340 - I/O #1 Input Line Low #1
341 - I/O #1 Input Line Low #2
342 - I/O #1 Input Line Low #3
343 - I/O #1 Input Line Low #4
344 - I/O #1 Input Line Low #5
345 - I/O #1 Input Line Low #6
346 - I/O #1 Input Line Low #7
347 - I/O #1 Input Line Low #8
348 - I/O #2 Input Line Low #1
349 - I/O #2 Input Line Low #2
350 - I/O #2 Input Line Low #3
351 - I/O #2 Input Line Low #4
352 - I/O #2 Input Line Low #5
353 - I/O #2 Input Line Low #6
354 - I/O #2 Input Line Low #7
355 - I/O #2 Input Line Low #8
356 - Time-Out Timer Message #1
357 - Time-Out Timer Message #2
358 - Time-Out Timer Message #3
359 - Time-Out Timer Message #4
360 - Time-Out Timer Message #5
361 - Time-Out Timer Message #6
362 - Time-Out Timer Message #7
363 - Time-Out Timer Message #8
364 - Time-Out Clear Message #1
365 - Time-Out Clear Message #2
366 - Time-Out Clear Message #3
367 - Time-Out Clear Message #4
368 - Time-Out Clear Message #5
369 - Time-Out Clear Message #6
370 - Time-Out Clear Message #7
371 - Time-Out Clear Message #8
372 - Pre-Access Port 1a
373 - Pre-Access Port 1b
374 - Pre-Access Port 2a
375 - Pre-Access Port 2b
376 - Pre-Access Port 3a
377 - Pre-Access Port 3b
378 - Pre-Access Port 4a
379 - Pre-Access Port 4b
380 - Pre-Access Port 5a
381 - Pre-Access Port 5b
382 - Pre-Access Port 6a
383 - Pre-Access Port 6b

384 - Pre-Access Port 7a
385 - Pre-Access Port 7b
386 - Pre-Access Port 8a
387 - Pre-Access Port 8b
388 - Reset Macro
389 - Temporary Macro
390 - User Timer 00 Expired
391 - User Timer 01 Expired
392 - User Timer 02 Expired
393 - User Timer 03 Expired
394 - User Timer 04 Expired
395 - User Timer 05 Expired
396 - User Timer 06 Expired
397 - User Timer 07 Expired
398 - User Timer 08 Expired
399 - User Timer 09 Expired
400 - User Timer 10 Expired
401 - User Timer 11 Expired
402 - User Timer 12 Expired
403 - User Timer 13 Expired
404 - User Timer 14 Expired
405 - User Timer 15 Expired
406 - Before Patch Off Hook
407 - After Patch On Hook
408 - Patch Busy Message
409 - Before Patch Number Readback
410 - After Patch Number Readback
411 - Dial Patch if Readback Interrupted
412..499 - Reserved
500..999 - User Macros

Appendix E
Reset and Initialization

The terms "reset" and "initialization" refer to totally different things on the RLC-3. The controller is "reset" when any of the following things happen:
*   the power is turned off and back on
*   the reset button on the motherboard is pressed and released
*   command C035 is executed

Resetting the controller does not cause you to lose any of your programming. It does restart all of the timers and a lot of other internal variables. If the controller is not doing what you think it should, try resetting it and see if things straighten out.

"Initialization" (sometimes called "re-initialization") resets all of the controller's internal settings back to the factory defaults. It does cause you to lose all of your programming. You will almost always have to initialize the controller when you install a new version of software, but rarely otherwise. If you are trying to learn to program the RLC-3 and you mess things up, you can use this to put everything back the way it is supposed to be. Initialization does not hurt the RLC-3 in any way - there is no EEPROM or anything to wear out. To reinitialize the RLC-3, follow one of the two methods below:

Method #1: Press and hold the INIT button on the motherboard. Turn on the power. Wait for about 3 seconds (or longer). Release the INIT button.

Method #2: Turn the power on. Press and hold the INIT button. Press and release the RESET button. Wait at least 3 seconds. Release the INIT button.

If you are successful you will hear the message "I-N-I-T" out of the transmitter that is hooked to port 1 and see the message "All settings have been reset to factory defaults" on the serial terminal.

Appendix F
Controlling a Rotor

The RLC-3 will evenually have specialized commands for controlling a rotor using the I/O lines on the I/O board, but you can do it now with a little work.

- Connect the rotor controls to two of the output lines. We will assume that you have one output for on/off and another to select the direction.

- Write a macro to turn the motor off. We will call this the "motor off macro"

- Write another macro that makes the rotor turn clockwise, the "clockwise macro". It should set the direction and turn the motor on.

- Write a macro that make the rotor turn counter-clockwise, the "counter-clockwise macro". It should set the direction and turn the motor on.

- Next, connect the output from the rotor that indicates the direction it is pointing to one of the analog input lines. If the voltage from that output ever goes above 5 volts (most go to the power supply voltage, about 13 volts), you should turn on the voltage divider dip switch on for that analog line. You should also make sure that the dip switch used to power a temperature sensor on that analog line is turned off.

- Use command C053 (or your favorite macro programming command) to program one of the user macros to execute C100 and make it read the analog line you hooked up in the previous step. Turn the rotor and make sure that the number it tells you changes. If it doesn't, check and make sure that the voltage going into the input line changes and that you have the dip switches set correctly. Don't worry about what number it tells you, just that it changes with the direction. If you want to make this macro have a nicer message, use C036 to build the message and speak variable word 512 (or one of the words nearby if you are using a different analog input) to insert the actual analog reading.

- This whole step is optional. If you do not want to know what direction the rotor is pointing, just have presets, skip this whole step. Most rotors indicate 180 degrees at south, increase as you go clockwise to 360 degrees at north, then jump to 30 degrees or some small reading and work their way back up to 180 degrees at south again. The direction voltage that is output from the rotor usually starts at 0 volts when the rotor is pointed south and increases to half scale at north and full scale when it gets all the way around to south on the other side. This makes it very difficult for the controller to calculate the degree reading, since it has a big break in the middle. Instead, we will make the controller read back the number of degrees clockwise from south. This is accomplished by setting the conversion ratio for the analog input with C102. The

following calculation assumes that you get 0 volts with the rotor all of the way counter-clockwise and 13 volts with the rotor all of the way clockwise.

$$\frac{13}{25} = \frac{360}{X}, \quad X = 25 * 360 / 13, \quad X = 692$$

This calculation shows that to get 360 degrees at 13 volts, we need to set the analog input to expect 692 degrees at 25 volts (the maximum input with the voltage divider input on). Assuming you are using analog input 1 on I/O board 1, the command would be:

C102* 1 1 0 0000 0 0692*

Now try reading the direction with the macro you wrote in the previous step. It should read 0 degrees with the rotor all of the way CCW, 180 degrees at north, and 360 degrees with the rotor all of the way CW. If it is off slightly, adjust the 692 used in command C102 to make it line up. Increase it if the readings are too large and decrease it if the readings are too small. Do not change the analog conversion ratio after you finish this step or you will mess up any presets you have made.

- Now we will set an analog low alarm at the most CCW position. Turn the rotor all of the way CCW. Read the direction. It should be 0 degrees (or close to it). To set the analog alarm (again assuming analog input 1 on I/O board 1):

    C104* 1 1 0 0 0000*

When that low alarm occurs, we want it to turn the rotor motor off. Double check to make sure you remember the command number of the macro you wrote in the first steps to turn the motor off. We will use command number 567 for this example, you can use the number of your macro. When the alarm occurs, it will call an analog low alarm macro. You can find the appropriate macro number in appendix D in the automatic macro section. We will assume you are using macro number 292. We want this macro to turn the rotor off, so we will make it call the rotor off macro:

    C053*292 567*

- You can test the alarm we set in the above step by executing the motor CCW macro we made and making sure that it turns itself off when it gets to the CCW limit. The RLC-3 checks the alarm every second by default, but you can speed it up if you want to. Simply change the "I/O Polling Timer" with command C020. A reset value of 10 (100 milliseconds = 1/10 of a second) is probably more than fast enough.

- We will also want to turn the rotor off when a analog high alarm occurs, so we will program the analog high alarm macro (number 276) to do the same thing as the analog low alarm macro:

    C053*276 567*

- Now we are ready to make a preset. We will use a macro to set the analog high alarm for the proper position and turn the rotor on in the clockwise direction. When it gets to the alarm point, it will turn itself off. Turn the rotor to a direction you would like to make a preset for. Read the direction with the macro we wrote earlier and write down the reading. Now program a macro to contain two commands: first set the analog high alarm to the direction reading you just wrote down, then call the motor CW macro. In the following example, the macro number will be signified by MMM, the analog line will be assumed to be line 1 on I/O board 1, the direction reading you wrote down is DDDD and the CW macro number will be CCC.

   C055*MMM*   (erase the old contents)
   C056*MMM 104 1 1 1 0 DDDD* (make the macro set the high alarm point)
   C056*MMM CCC*   (make the macro start the rotor clockwise)

- Turn the rotor all of the way CCW with the CCW macro. From now on you can use this macro as a "reset rotor" command. You will need to execute it and wait for it to finish turning all of the way CCW before you tell the rotor to go to each new preset. You may want to change the name of this macro with C110.

- Now try the preset we set two steps ago by executing macro MMM. It should start the rotor turning clockwise. The high alarm should stop it when it gets to the proper position.

- Reset the rotor and try the preset again. If everything works, rename the preset macro (MMM) to some descriptive name with C010 and make more presets.

Appendix G
Programming with the Serial Port

Entering commands from the serial port works almost exactly the same way as with DTMF tones from a radio. The characters you enter on the keyboard are treated the same way as the digits on your radio keypad. Of course you can enter digits on the keyboard that you can not enter from a keypad, which gives you a little additional flexibility. Some of the things you can do from the keyboard that you can not do from a DTMF pad are:

*   Back up. If you type a digit you did not mean to type, simply press the backspace key and delete it.

*   Press the Enter key. This tells the controller to try to execute whatever you have typed so far. This is exactly the same as unkeying your radio to force a command to execute. When you have entered a command you can either enter a '*' or press enter to make it execute.

*   Store a bunch of commands in a file on your computer that you can upload them without typing them again. See the section on using a serial upload file later in this appendix..

*   Note: do not put any spaces in the commands you enter from the serial port. The only exception to this if you are programming a serial message with command C032 and you want a space in your serial message. The spaces that are shown in the manual are just to make it easier to see which digits go together.

Example: I want to execute Command C009 to see which ports are connected together:

     Over the air:
          <Key radio> C009 <Unkey or press "*">

     From the serial port:
          <ENTER>
               You will see the serial port prompt "DTMF>". This indicates that the characters
               you enter are being treated just as if they were entered by DTMF from a radio port
          C009 <Enter or press "*">

Example: I want to execute Command C000 to connect ports 1 and 3 together:

     Over the air:
          <Key radio> C000*13 <Unkey or press "*">

     From the serial port:
          <ENTER>
          C000*13 <Enter or press "*">

     Now try C009 (the first example) again. The crosspoint will show that ports 1 and 3   are

not connected.

Voice responses to commands entered serially:

By now you may have noticed that most commands provide both a voice and a serial response. Every command that is executed from the serial port or a radio port by DTMF will always provide a serial response. You can control whether or not you get voice responses to the commands you enter serially with command C050. Using that command you can tell the RLC-3 to send the voice responses out any port, more than one port, or nowhere at all. Normally it sends them out port one, so if you haven't heard the voice yet, you can hook up and transmitter to port 1, enter serial commands, and hear the voice responses.

Using a serial upload file:

A very convenient way to set up your controller if you have a computer is to type all of the commands that you use to set up your controller in a file using a word processor. Save the file in ASCii format. Load your communications program and make sure you are talking to the RLC-3 by hitting return and making sure you get the "DTMF>" prompt. Now do an ASCii upload of the file that you saved all of your commands in. Test the stuff you uploaded and if you want to make a change, go back to your editor and change it in the file. Now upload it again. By setting up your controller this way, you have a permanent record of everything you have done. If something ever gets messed up on the controller, all you have to do is initialize it (see Appendix E) and re-upload your file. Also, when you get a new version of software (which will almost always require you initialize), you will probably only have to make minor changes to your file to make it work with the new software version. This will definitely save you time in the long run. An example will illustrate the idea:

    Using your favorite editor, enter the following (including the comments):
        ; this line is a comment - put a description of the file here
        C050*0*   Turn off the voice responses to serial commands
        C000*12*   Connect ports one and two
        C007*11*   Turn DTMF muting on for port 1
        C050*01*   Turn on voice responses to port 1
        C036*116*   Speak the word "Complete"
    Save the file as SETUP or some other name of your choice.
    Load your communications program.
    Hit <enter> and watch for the "DTMF>" prompt from the RLC-3. If you do not   get
it, check your cable and setup in your communications software.
    You may want to tell your communications program to open a log file at this point.
        It will come in handy for checking if any of the commands caused errors.
    Start an ASCii upload of your file.
    Wait until it finishes.
    Close the log file if you opened one.
    Try out your new settings. C009 will check the crosspoint and C008 will check the
    DTMF muting.
    Go back to your editor, make the required changes, and repeat the cycle.

Note about comments in serial upload files: You may have wondered how the controller knows which parts of your serial upload file are commands and which parts are comments. The answer is that any time the controller looks for a command and the first character it sees is a space or a semicolon, the rest of the line is considered to be a comment. What about the comments that are on the same line as a command? As the controller looks at each line of your file, it watches for a '*' or a carriage return to indicate that the command has been entered and can be executed. You will note that all of the lines in the example file above have a '*' at the end of the command. When the controller sees the '*' it executes the command, and starts reading from the file again, looking for another command. When it sees the spaces after the '*', it knows that the rest of the line is a comment.

When you are commenting your own files, you can add comments in two ways: start a line with a space or semicolon, or enter your commands with a '*' after them, then space over to the right and add your comments there.

Note about capital letters: By default the RLC-3 converts everything you type to a capital letter. This is because DTMF characters are always treated as capital letters and it avoids confusion. However, there may be a time when you would like to enter lower case letters, such as when you send serial messages with command C032. At those times you can turn off the conversion to all capital letters with command C060.

Note about download speeds: If you download a file with more than a dozen commands or so in it, you may find that the responses from the RLC-3 get way behind, or even get lost with the message "Serial Output Queue just overflowed - it now looks empty". This is caused by the RLC-3 trying to send back all of the descriptive responses to the commands and not being able to send the responses as fast as it gets new commands. Eventually it runs out of buffer space and is forced to throw some of the responses away. This does not affect the commands that are being sent to the RLC-3 in any way - just the responses. If you do not care about the responses, just let them get thrown away and forget it. If you need to know what the responses are, change the ASCii transfer settings on your communications software to insert a 1.5 second delay after each line (longer for slow baud rates, shorter for fast baud rates). This will give the RLC-3 time to send the responses back without overflowing the queue. It will slow down the transfer considerably, but that is the tradeoff.

Appendix H
ASCII Chart

This chart may be helpful when programming serial messages with C034. Not all of the codes are included because not all of them are universally used and some don't print well.

032	072 H	112 p	153 Ö	193 ⊥	233 1
033 !	073 I	113 q	154 Ü	194 ⊤	234 S
034 "	074 J	114 r	155 ¢	195 ⊢	235 *
035 #	075 K	115 s	156 £	196 –	236 4
036 $	076 L	116 t	157 ¥	197 ┴	237 N
037 %	077 M	117 u	158 Pt	198 ⊨	238 ,
038 &	078 N	118 v	159 ƒ	199 ╟	239 1
039 '	079 O	119 w	160 á	200 ╚	240 /
040 (	080 P	120 x	161 í	201 ╔	241 ±
041)	081 Q	121 y	162 ó	202 ╩	242 $
042 *	082 R	122 z	163 ú	203 ╦	243 #
043 +	083 S	123 {	164 ñ	204 ╠	244 !
044 ,	084 T	124		165 Ñ	205 =	245 "
045 -	085 U	125 }	166 ª	206 ╬	246 ÷
046 .	086 V	126 ~	167 º	207 ╧	247 .
047 /	087 W	128 Ç	168 ¿	208 ╨	248 E
048 0	088 X	129 ü	169 1	209 ╤	249 @
049 1	089 Y	130 é	170 ¬	210 ╥	250 ·
050 2	090 Z	131 â	171 ½	211 ╙	251 %
051 3	091 [	132 ä	172 ¼	212 ╘	252 ⁿ
052 4	092 \	133 à	173 ¡	213 ╒	253 ²
053 5	093]	134 å	174 «	214 ╓	254 ■
054 6	094 ^	135 ç	175 »	215 ╫	255
055 7	095 _	136 ê	176 ░	216 ╪	
056 8	096 `	137 ë	177 ▒	217 ┘	
057 9	097 a	138 è	178 ▓	218 ┌	
058 :	098 b	139 ï	179 │	219 █	
059 ;	099 c	140 î	180 ┤	220 ▄	
060 <	100 d	141 ì	181 ╡	221 ▌	
061 =	101 e	142 Ä	182 ╢	222 ▐	
062 >	102 f	143 Å	183 ╖	223 ▀	
063 ?	103 g	144 É	184 ╕	224 "	
064 @	104 h	145 æ	185 ╣	225 ß	
065 A	105 i	146 Æ	186 ║	226 '	
066 B	106 j	147 ô	187 ╗	227 B	
067 C	107 k	148 ö	188 ╝	228 E	
068 D	108 l	149 ò	189 ╜	229 F	
069 E	109 m	150 û	190 ╛	230 µ	
070 F	110 n	151 ù	191 ┐	231 J	
071 G	111 o	152 ÿ	192 └	232 M	

Appendix I
Using the LM335 Temperature Sensor

The RLC-3 supports the National Semiconductor LM335Z temperature sensor. The sensor converts temperature into voltage. This voltage is read by the controllers ADC (Analog-Digital Convertor) which allows the controller to read a voltage. When using the LM335Z sensor, the sensor needs to be powered in order for the temperature to be read. Powering the sensor is accomplished by turning the appropriate dip switch 'ON' on the I/O board. There are two packs of 8 switches, one pack for power and and one for the voltage dividers. The power switch must be on and the voltage divider switch off for the temperature sensor to work.

LM 335 Z

FLAT SIDE FACING

N/C   +OUT   RLC-3 Analog Input

-GND
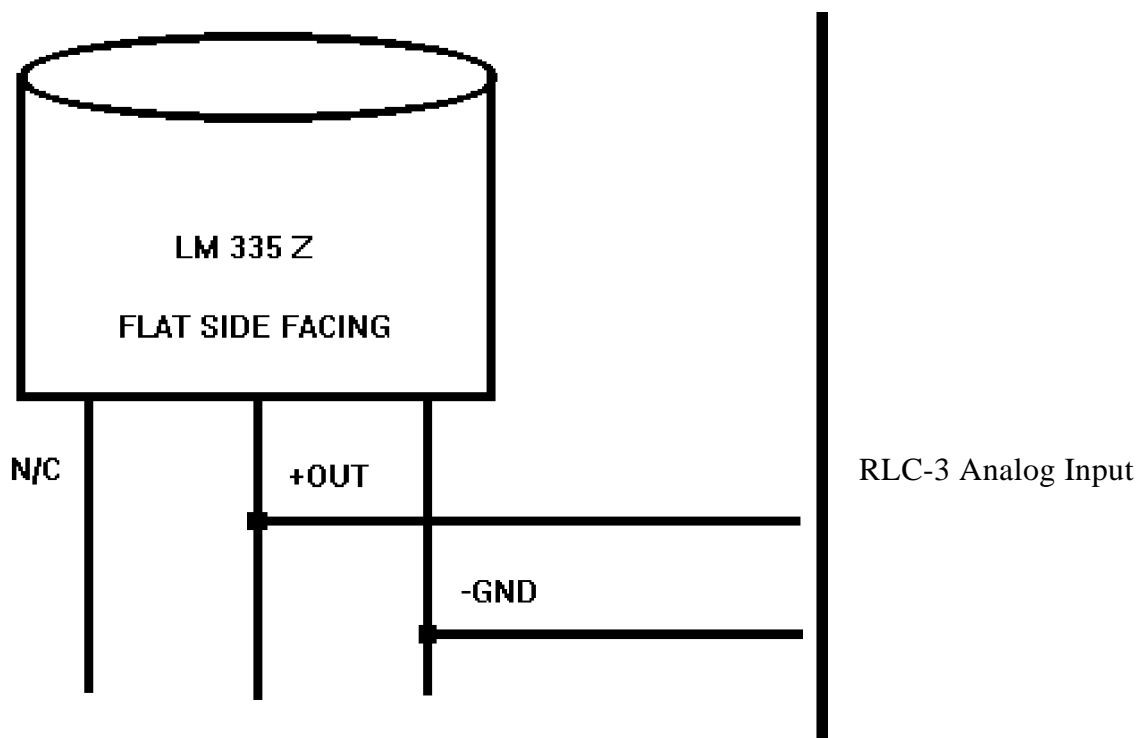
LM335Z Temperature Probe Connections Diagram

Software Problem and Request Form

Link Communications Inc. Numbers: 406 - 482 - 7547 (Fax)   406 - 482 - 7515 (Voice)

Name   _____

Serial #   _____

Phone #   _____   Fax # _____

Request: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Attention Allan or Steve   Number of Pages: _____

Software Problem and Request Form

Link Communications Inc. Numbers: 406 - 482 - 7547 (Fax)   406 - 482 - 7515 (Voice)

Name   _____

Serial #   _____

Phone #   _____   Fax # _____

Request: _____

_____

_____

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_____

_____

_____

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_____

_____

_____

_____

_____

_____

Attention Allan or Steve   Number of Pages: _____

Component Layout

Main Board

Radio Board

I/O Board

Power Board

Autopatch Board

Jumper and Switch Locations

Main Board Important Connections

```
                                    ┌──────────┐        ┌────────┐
                                    └──────────┘        └────────┘
                                      DISPLAY              BKG

              ┌───┐   VOICE
              │   │   LEVEL
              └───┘   ADJUSTMENT


                                        INITIALIZE
                                          ┌───┐    ┌───┐
                                          │   │    │   │
                                          └───┘    └───┘
                                                   RESET



                                     AUDIO LEVEL TEST BUS        ┌─┐
                               P4    ┌────────────────┐          │ │
                                     └────────────────┘          │ │
                                                                 │ │
                                  RS-232 I/O    +12V             │ │
                                   ┌──────┐    ┌────┐            │ │
                                   │      │    │    │    POWER   └─┘
                                   │      │    │    │    BOARD
                                   └──────┘    └────┘
```
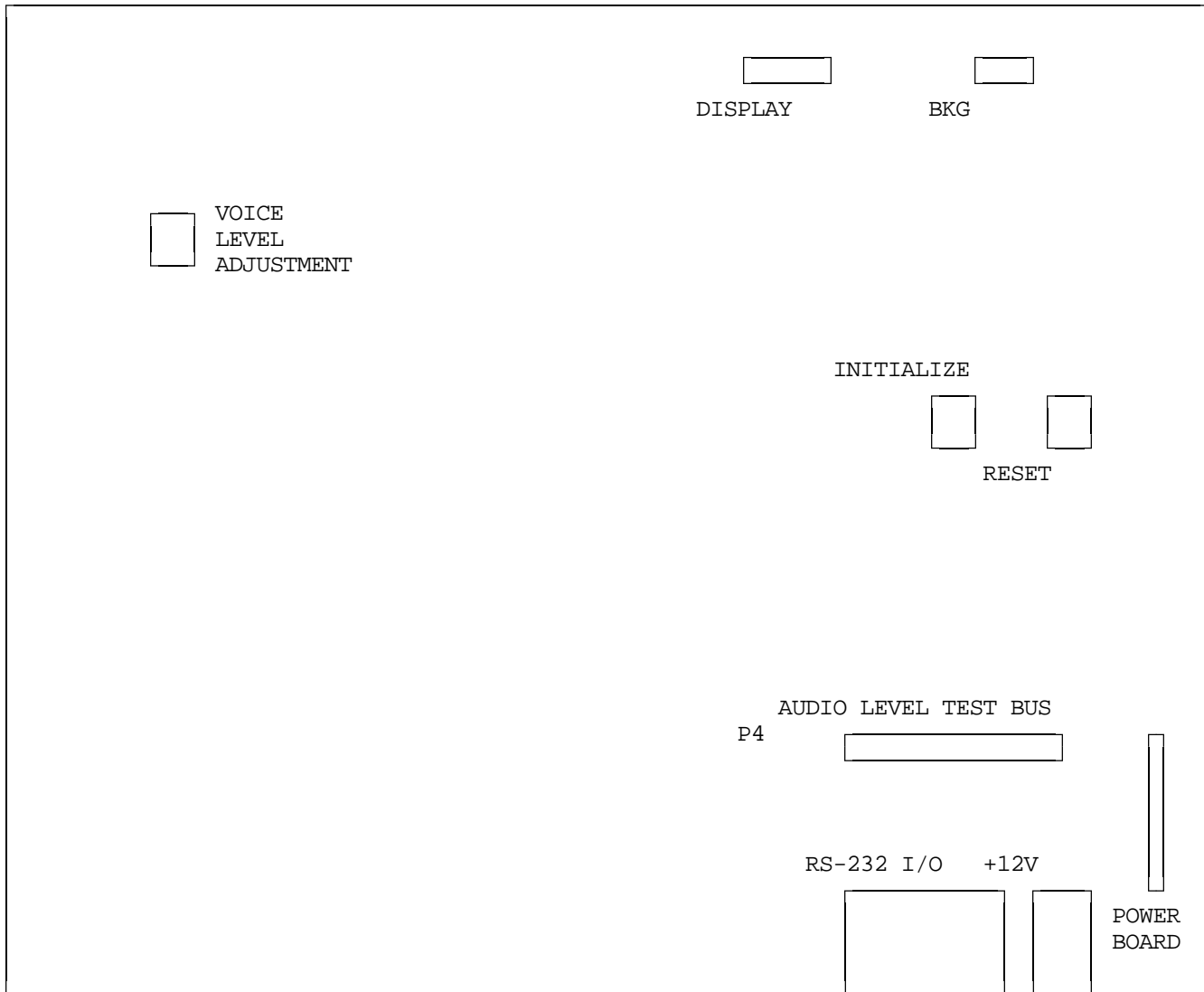
Adjustments:

   Voice level adjustment allows you to vary the level of the voice synthesis generator. Adjust this level to 2 Khz. deviation.

Test Bus:

   P4 test bus is provided to allow you to look at the different audio sources used on the controller.

Power Board:

   The power board connector is the connection used to power the external power regulator board. This connector is polarized so reverse connections is not possible. Refer to the Power Board sheet following for specifics on the power board.

Initialize and Reset switches:

   These switches are provided to allows the manual resetting and initialization of the controller. See

Appendix E for instructions about how to perform the initialization.

Radio Board Important Connections

```
              TRANSMIT
   RECEIVE    |  TONE  LEVEL
  ┌──────────────────────────────────┐        ┌──────────┐
  │  ┌────┐ ┌────┐ ┌────┐            │        │ □□□□□ │   ON
  │  │ RX │ │ TX │ │ TN │            │        └──────────┘    8
  │  └────┘ └────┘ └────┘            │         1 2 3 4 5  OFF │
  │          4 3 2 1                 │         CONFIGURATION
  │ ┌─┐ S                            │
  │ │ │ E      ┌─────────┐   J5      │
  │ │ │ R   J3 │O O │O─O│           │
  │ │ │ I      └─────────┘  ┌───┐    │
  │ │ │ A                   │ O │ 1  │
  │ │ │ L      ┌─────────┐  │ O │ 2  │
  │ └─┘     J1 │O O │O─O│  │ O │ 3  │
  │            └─────────┘  │ O │ 4  │
  │          4 3 2 1        └───┘    │
  │ ┌─┐ R                            │
  │ │ │ A                            │
  │ │ │ D                            │
  │ │ │ I                            │
  │ │ │ O                            │
  │ └─┘                              │
  │                                  │
  │        ┌────────────────────┐    │
  │        │ PORT 1,2,3,4,5,6,7,8│   │
  │        └────────────────────┘    │
  └──────────────────────────────────┘
```
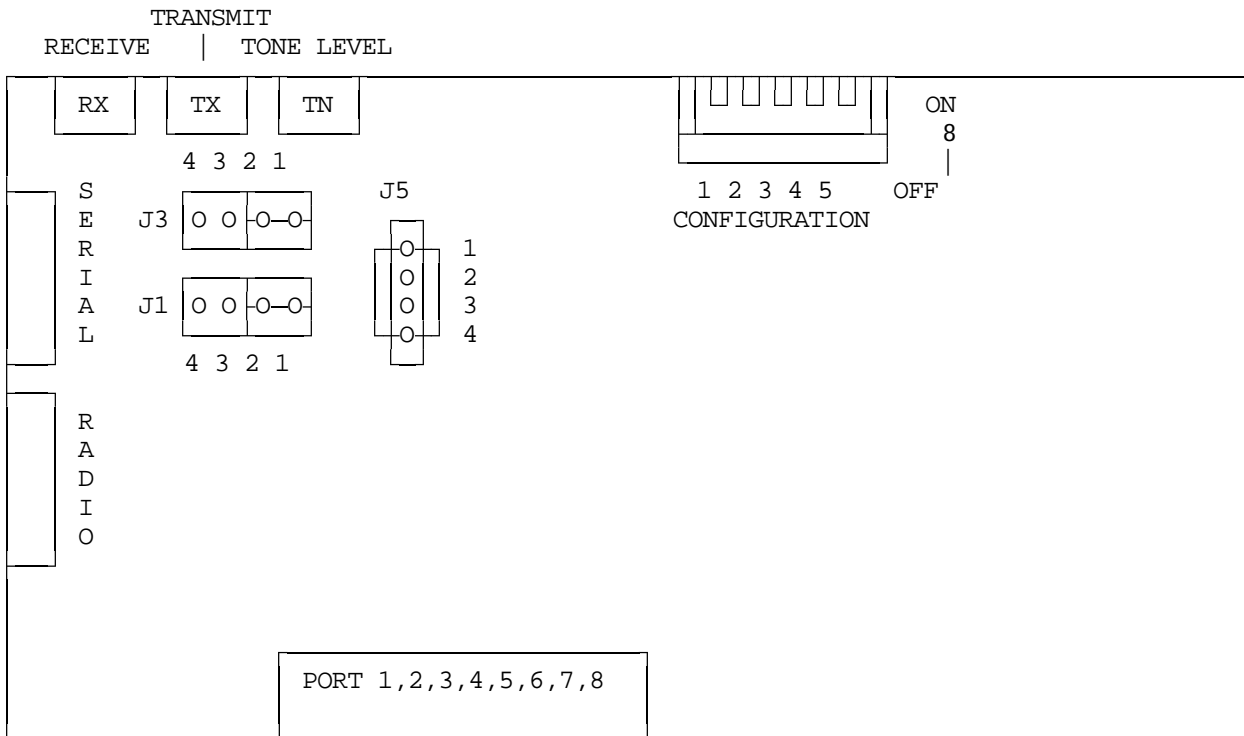
J3 - RECEIVE AUDIO PATH

J4 - TRANSMITTER AUDIO PATH

- WHEN THE JUMPER IS ON PINS 2,1 AUDIO PATH IS NOT BROKEN

- WHEN JUMPER IS REMOVED, AUDIO PATH IS BROKEN

- PIN 3 IS GROUND REFERENCE

- PIN 4 IS +10 VOLTS

J5 - RS-232/TTL SELECTION

- WHEN THE JUMPERS REMOVED, RS-232 IS PRESENT

-- REQUIRES A DALLAS DS 1275 TRANSLATOR CHIP

- WHEN THE JUMPERS ARE PRESENT, TTL SIGNALS FROM THE 68HC11 ARE PRESENT

-- THIS MODE IS USED FOR DOUG HALL AND RLC-ICM CONTROL

 *** DO NOT JUMP PINS 1,2 AND 3,4 WHEN A DS 1275 IS IN CIRCUIT, YOU WILL
        DAMAGE THE DS 1275, AND POSSIBLY THE MICROPROCESSOR ***

S1 CONFIGURATION SWITCH

   1 - AUDIO DE-EMPHASIS CIRCUIT ON/OFF (DEFAULT OFF, OUT OF CIRCUIT)

   2 - COR POLARITY SWITCH , 3 - PL POLARITY SWITCH (BOTH DEFAULT ACTIVE LOW)

      ON = UP = ACTIVE LOW (SIDE PUSHED DOWN)

      OFF = DOWN = ACTIVE HIGH TIME

   4 - AUX. #1 SWITCH, CURRENTLY NOT DEFINED

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5 - AUX #2 SWITCH, CURRENTLY NOT DEFINED

I/O Board Important Connections

```
                                        1 2 3 4 5 6 7 8   ON
                                                                    8
                               S2     ┌─┬─┬─┬─┬─┬─┬─┬─┐         │
  ┌──┐                                └─┴─┴─┴─┴─┴─┴─┴─┘        OFF
  │A │                                 ANALOG VOLTAGE
  │N │                                 DIVIDER SWITCH
  │A │
  │L │
  │O │          1 2 3 4 5 6 7 8   ON
  │G │                                    8
  │  │   S1    ┌─┬─┬─┬─┬─┬─┬─┬─┐     │
  │& │         └─┴─┴─┴─┴─┴─┴─┴─┘    OFF
  │  │          ANALOG TEMPERATURE
  │I │            POWER SWITCH
  │/ │
  │O │
  └──┘

              ┌───────────────────────────┐
              │  USER PORT #1 AND #2       │
              └───────────────────────────┘
```
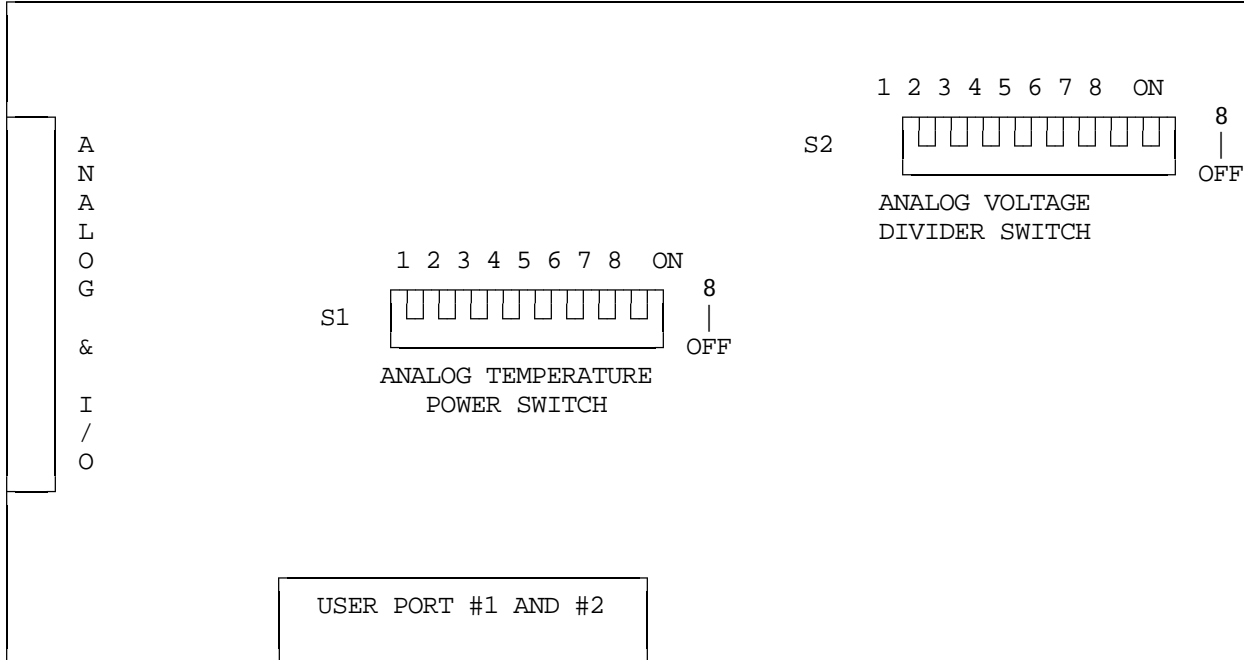
S1 - Analog Temperature Power Switch
  - This switch allows you to externally power the LM335 Temperature Sensor
  -- When the switch is on, +10v is feed to the external sensor

S2 - Analog Voltage Divider Switch
  - This switch allows you to directly read 0.00v - 25.0 volts
  -- When the switch is on, the voltage divider in circuit

Power Board LED Definitions

```
┌─────────────────────────────────────────────────────────────────┐
│   O   VOLTAGE IN                                                  │
│                                                                   │
│                                                                   │
│                                   ┌──────────────┐                │
│   O   FUSED VOLTAGE INPUT         │              │                │
│                                   │   CR2025     │                │
│                                   │              │                │
│                                   │    3V        │                │
│                                   │              │      P   ┌───┐ │
│   O   10 VOLTS REGULATED          │   BATTERY    │      O   │   │ │
│                                   │              │      W   │   │ │
│                                   └──────────────┘      E   │   │ │
│                                                             │   │ │
│   O   5 VOLTS REGULATED                              R      │   │ │
│                                                             │   │ │
│                                   ┌──────────────┐      I   │   │ │
│                                   │ 1.5 AMP FUSE │      N   │   │ │
│   O   2.5 VOLTS REGULATED         └──────────────┘         └───┘ │
│                                                                   │
└─────────────────────────────────────────────────────────────────┘
```
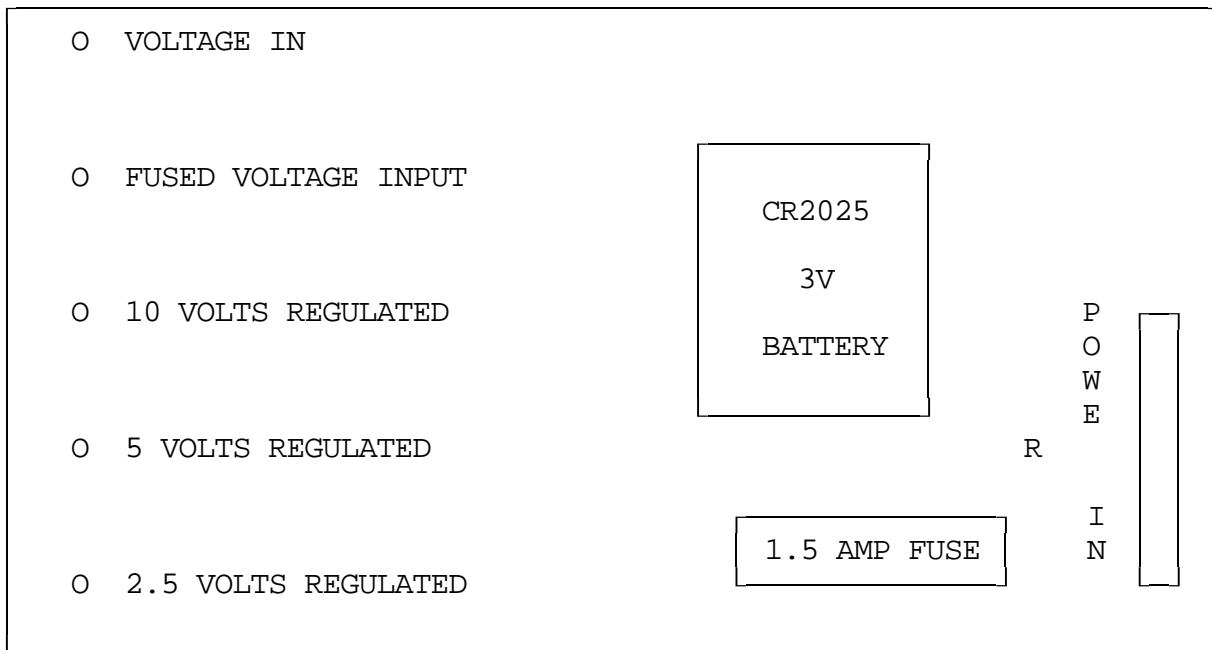
Power Board LED Indicators
- Voltage In LED indicates that voltage is reaching the Power Board
- Fused Voltage Input indicates voltage has passed through the fuse
- 10, 5, 2.5 volts regulated are the power Boards output
- There is no indication for the 3v lithium battery

*** If the **Voltage In** LED is lit, but no other LED are lit, the fuse is bad ***

Bill of Materials

RLC-3 Main Controller Board Parts

```
Item   Quantity   Reference                Part
_____

  1        1      C3                       2000pF
  2        1      C4                       68pF
  3        1      C5                       100pF
  4        3      C6,C19,C20               0.01uF
  5       25      C7-C12,C14,C25-C43       0.1uF
  6        1      C13                      1uF
  7        2      C15,C16                  22pF
  8        4      C21,C22,C23,C24          10uF
  9        1      J1                       2x5 Header
 10        1      J2                       2x7 Header
 11       11      J3,J4,J5,J6,J7,J8,J9,J10, AMP Female Connector
                  J11,J12,J13
 12        1      L1                       10uH Inductor
 13        1      P1                       2.50mm Power Jack
 14        1      P2                       DB-9 Right Angle Female
 15        1      P3                       7-MOLEX Power Access Connector
 16        1      R1                       510 Resistor
 16a       6      R5,R9,R11,R12(Var)R16,R17 10K Resistor
 17        2      R3,R4                    24.9K Resistor
 18        9      R6,R7,R8,R15(SIP),R20(SIP)47K Resistor
                  R21(SIP),R23(SIP),R25(SIP)
                  R27(SIP)
 19        2      R10,R26                  1K Resistor
 20        1      R18                      10M Resistor
 21        1      R19                      330K Resistor
 22        1      R24                      5K Resistor
 23        1      S1,S2                    Pushbutton Switch
 24        1      U1                       National LMC660AIN
 25        1      U3                       Motorola MC68HC16Z1
 26        4      U4,U5,U6,U7              27010-150 Eprom
 27        1      U8                       74HC04
 28        1      U9                       DS1232
 29        1      U11                      DS1221
 30        1      U12                      DS1286
 31        1      U13                      TI TSP53C30
 32        2      U14,U15                  KM681000ALP-7L 128Kx8
 33        1      U16                      3.579545 Mhz Oscillator
 34        1      U17                      74HC244
 35        1      U18                      8.00 Mhz Oscillator
 36        2      U19,U23                  74HC574
 37        5      U20,U21,U24,U25,U26      74HC4066
 38        2      U22,U27                  74HC138
 39        1      U28                      MAX-232
 40        1      Y1                       32.768 KHZ Tuning Fork Crystal
 41        1      Y2                       3.2768 Mhz Crystal
```

RLC-3 Radio Port Parts

Item	Quantity	Reference	Part
1	2	C1,C10	100pF
2	3	C2,C13,C15	4.7uF
3	5	C3,C4,C5,C6,C7	470pF
4	10	C8,C9,C11,C12,C18-C23	0.1uF
5	1	C17	220pF
6	1	D1	1N4754A
7	2	D2,D3	1N750A
8	2	D4,D6	Red LED
9	2	J1,J3	4x1 Header
10	1	J4	26 Pin Right Angle Female
11	2	P1,P2	DB-9 Right Angle Female
12	1	Q2	2N7000
13	5	R1,R5(SIP),R16(SIP) R17(SIP),R23	47K Resistor
14	1	R2	1K Resistor
15	1	R3	680 Resistor
16	4	R4,R7,R8,R15(Var)	10K Resistor
17	2	R9,R10	5.1K Resistor
18	4	R6(Var),R13,R14,R24(Var)	100K Resistor
19	1	R12	300K Resistor
20	2	R20,R22	470 Resistor
21	1	S1	5 Position Dip Switch
22	3	U1,U2,U15	74HC4066
23	2	U14,U3	Motorola MC33202P
24	1	U4	Teletone M-8870-01
25	1	U5	Motorola 68HC11E1
26	1	U6	74HC573
27	1	U7	27C512-200
28	1	U8	DS1275 (Optional)
29	1	U9	AD557JN
30	1	U10	74HC138
31	1	U11	74HC05
32	1	U12	74HC21
33	1	U13	74HC574

RLC-3 Power Board Parts

Item	Quantity	Reference	Part
1	1	BT1	3V LITH - CR2025
2	3	C1,C3,C6	1uF
3	2	C2,C5	10uF
4	1	C4	220uF
5	4	D1,D2,D3,D4	1N4000
6	5	D5,D6,D7,D8,D9	RED LED
7	1	F1	1.5 AMP FUSE 5mm
8	1	J1	7 PIN MOLEX POWER CONNECTOR
9	1	L1	10uH
10	2	RG1,RG2	LM317T
11	3	R1,R3,R4	237 RESISTOR
12	1	R2	1.69K RESISTOR
13	3	R5,R6,R8	1K RESISTOR
14	1	R7	510 RESISTOR
15	1	R9	270 RESISTOR
16	1	U1	LM78S05CT, TO-3
17	1	CABLE	5" POWER CABLE

RLC-3 I/O Board Parts

Item	Quantity	Reference	Part
1	24	C1,C2,C3,C4,C5,C6,C7,C8, C17,C18,C19,C20,C21,C22, C23,C24,C25,C26,C27,C28, C29,C30,C31,C32	470pF
2	10	C9,C10,C11,C12,C13,C14, C15,C16,C33,C35	0.1uF
3	1	C34	10uF
4	8	D9,D10,D11,D12,D13,D14, D15,D16	1N750A
5	1	J1	26 PIN RIGHT ANGLE
6	1	P1	DB-25 RIGHT ANGLE FEMALE
7	1	R1(SIP)	2.4K RESISTOR
8	1	R2(SIP)	47K RESISTOR
9	2	R3(DIP),R5(SIP)	10K RESISTOR
10	1	R4(SIP)	40K RESISTOR
11	2	S1,S2	8 POSITION DIP SWITCH
11	2	U1,U7	74HC574
12	2	U2,U3	NATIONAL LMC660AIN
13	1	U4	74HC244
14	1	U5	ALLEGRO UD2596A
15	1	U6	74HC138
16	2	U8,U9	74HC4066

RLC-3 Autopatch Board

Item	Quantity	Reference	Part
1	1	C1	0.1uF
2	1	C2	4.7uF
3	1	C3	220uF
4	1	C4	1uF
5	4	D1,D2,D4,D5	LED
6	1	D3	1N4004
7	1	D6	1N750A
8	1	J1	RJ11
9	2	J2,J5	2x1 HEAD
10	1	J3	3x1 HEAD
11	1	J4	4x1 HEAD
12	1	K1	DIP RELAY SPST
13	1	P1	DB9RAF
14	1	P2	2.5mm
15	2	Q1,Q2	2N7000
16	3	R1,R6,R12	10K
17	4	R2,R4,R11,R15	1K
18	2	R3,R5	100K
19	1	R7	680
20	2	R8,R14	510
21	4	R9,R10,R16,R17	47K
22	1	R13	470
23	1	U1	MC33202
24	1	U2	M-929-01
25	1	U3	DS2249
26	1	U4	74HC05
27	1	U5	LM7805

Schematic Diagrams